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PLANT OF C. RUMPP & SONS' BUILDING

New Boilers and Engines Installed With Slight Interruption of Service

BY WALTER C. EDGE

WITH A LOSS OF LESS than an hour in production of power, new boilers and engines were installed recently in the building occupied by C. Rumpp & Sons, Philadelphia. The plant furnishes heat, light and power for an 8-story building in which fancy leather goods are manufactured, motor driven machinery being employed. In making the change of equipment, the new boilers were placed in the 1-story addition to the main building, and when ready for service, were connected to the steam line. Then, the old boilers were torn down and the site utilized for the new engine room. By this method, the only loss of power production caused was during the time the necessary connections to the new apparatus were being made.

Boilers being set out from the walls, there is a passageway all around them and with plenty of light and ventilation the room has a pleasant appearance being floored with cement and neatly finished.

Two horizontal return tubular boilers, each of 75 hp. capacity, constitute the steam generating equipment, and are suspended independent of the brick work. The boiler fittings consist of plain water col-

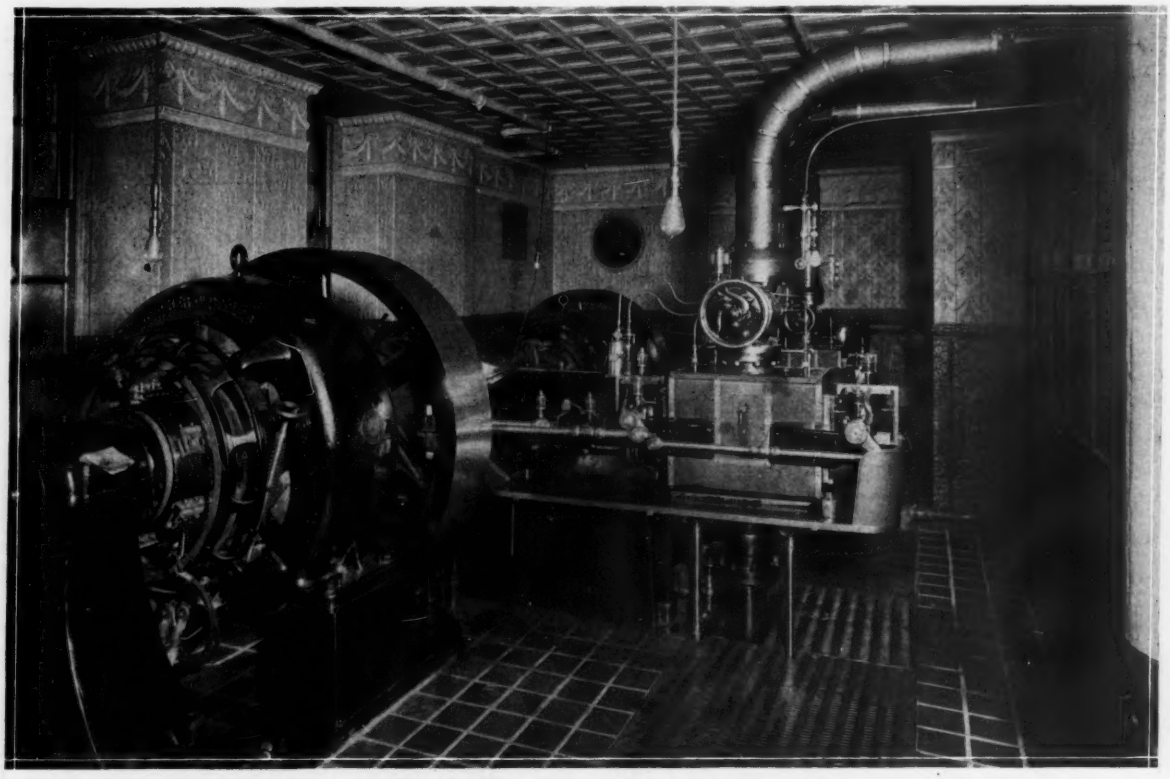


FIG. 3. VIEW OF ENGINE ROOM SHOWING GENERATING UNITS

umns, P. B. H. weighted gage cocks, Pittsburgh chain lever water gages and Ashton pop safety valves. The damper is controlled by a Spencer automatic regulator. Serving these boilers is a 30-in. steel stack, 115 ft. in height, connected by a breeching to the front of the boilers.

Apparatus for the handling of coal and ash consists of a screw type conveyor placed beneath the

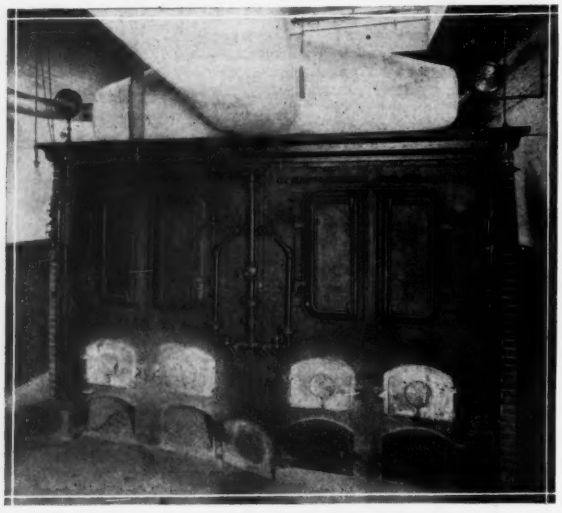


FIG. 1. VIEW OF NEW BOILER ROOM

floor which conveys coal from the street to the storage bins and a steam-hydraulic lift by which ash is elevated to the sidewalk level.

Water supplied to the plant is city filtered water brought in by a 2-in. main under city pressure and passed through 2 Hungerford filters before being used anywhere in the building. On the roof of the building are 4 water tanks, 2 open and 2 kept at a pressure of 75 lb. by a Westinghouse 8 by 6 by 9 in. air compressor. The tanks can be used for fire protection and in addition to these a twin connection is provided from the street, all of which are connected to an automatic sprinkling system. Supplying the tanks are 2 tank pumps, a 6 by 4 by 6 and a 4½ by 2¾ by 4, Laidlaw-Dunn-Gordon, equipped with automatic pump governors and automatic tank regulators.

Feed water may be supplied to the boilers by 2 separate systems, either by the feed pump or through a 2-in. pipe direct from the city main to an injector which discharges into the boiler through the blow-off pipe. This makes it possible to work on the feed lines without shutting down.

Under normal circumstances, however, the boiler feed pump, which is a duplex 5¼ by 3½ by 5 in. of Warren make, takes water from a receiver 30 by 48 in. fed by the heating returns, the level of the water in the receiver controlling the speed of the pump by means of a Fitts chronometer regulating valve. Should the pump be feeding too fast it is necessary to cut down on the water supply to the receiver, which action causes the regulating valve to cut down on the steam supply to the pump.

Connections are so made to the boiler feed pump that it can take water from any one of 4 sources; the feed water heater, the receiver, the filters or from the city main direct. It discharges through a 2-in. line which branches into 2 1¼-in. lines on the boiler fronts, one to each boiler.

Piping and Heating

THE plan shown gives an idea of the general piping arrangement. Steam is conducted from the boilers through 4-in. extra heavy bends, equipped with angle and globe valves, into an 8-in. manifold 12 ft. long

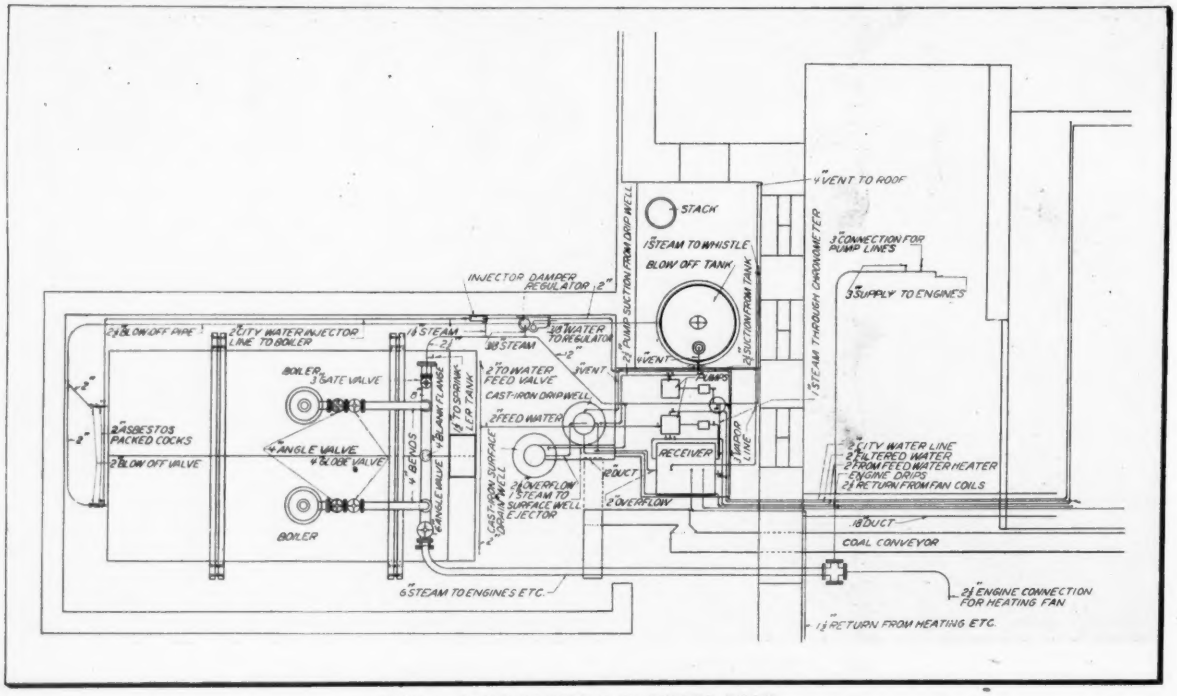


FIG. 2. PLAN OF PIPING IN BOILER ROOM

which extends over the front end of the boilers. Leading from this header are 2 branches, one 6-in. and one

3-in., with a 4-in. blank flange for future use, all nozzles welded by the acetylene process.

The exhaust from the engines is carried away in lines beneath the engine room floor through ducts made for that purpose.

The blowoff lines, each of which is fitted with a 2-in. asbestos-packed cock and a 2-in. Eastwood blowoff valve, are of 2-in. extra heavy piping and run to a blowoff tank sunk in the floor just outside the boiler room. This tank has a 4-in. vent to the roof and is connected to the suction by a 5¼ by 3½ by 5 in. pump.

The receiver of the heating returns is set in a pit with the boiler feed pump and overflows through a 2-in. pipe into a cast-iron drip well which in turn overflows through a 2½-in. pipe into a cast-iron surface drain well which can be emptied by an ejector. Both the drip well and the receiver are connected to the vent to the roof and a 2½-in. suction line runs from the drip well to the blowoff tank pump. For emptying the pump pit, should it become flooded, an ejector has been installed.

Two methods of heating are employed in the building, the old building being heated by the Sturtevant hot-air system while the new addition is heated by live steam through a reducing valve, the returns being lead to the receiver through 1½ and 2½-in pipes.

Engines and Electrical Equipment

THE engine room floor is 3 ft. above that of the boiler room and is of red tile, the walls and ceiling are of steel which adds to the beauty of highly polished engines and bright work.

For the generation of electric current used on a 3-wire system, 2 units are installed. One is a 13 by 13-in. Fitchburg engine of the 4-valve side crank type, direct connected to a Crocker-Wheeler 60-kw. generator running at 225 r. p. m. and supplying current at 110 volts. The other is of similar construc-

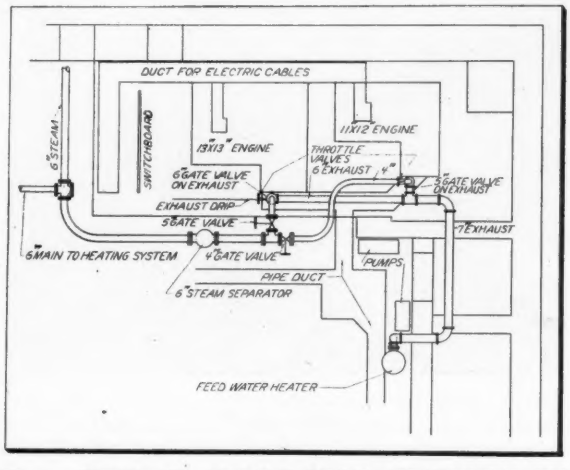


FIG. 4. STEAM AND EXHAUST PIPING ARRANGEMENT FOR NEW ENGINES

tion, an 11 by 12-in. engine being used on a 40-kw. generator running at 260 r. p. m.

Both engines are equipped with McDaniell traps for draining the cylinders. Oil is supplied under pressure to a lubricator on each engine from a wall tank, a hand pump connected to the steam pipe provides for an emergency, and cylinders are oiled by means of a Sterling lubricating pump. The engines being of different sizes makes it possible to take care of light, medium and heavy loads economically.

Electric current generated by these units is supplied to 8 motors for manufacturing purposes, to an electric elevator, to an electric pump which supplies water to the sprinkling system for fire protection, and to the lighting circuit. The switchboard is of white marble set 4 ft. from the wall at one end of the engine room. It is equipped with 2 Weston ammeters, a Weston voltmeter, Cutter circuit breakers, a Sangamo wattmeter and a Westinghouse recording ammeter. The board is also fitted for central station current which can be used in emergencies.

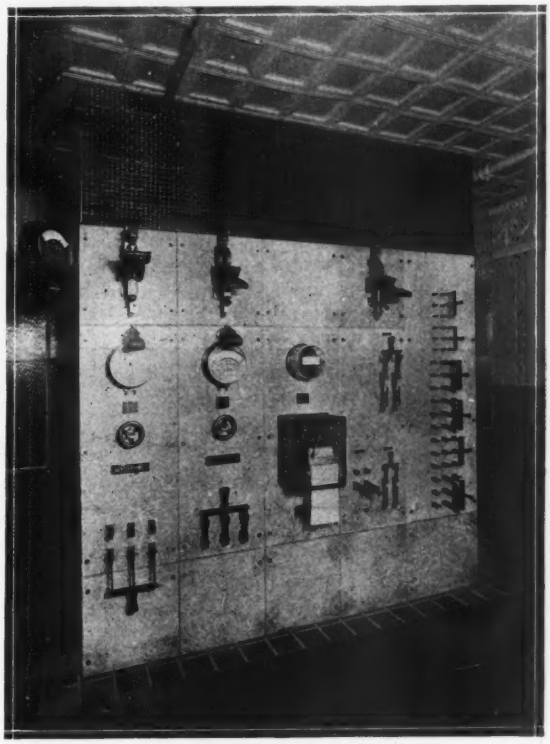


FIG. 5. ENGINE ROOM SWITCHBOARD

All motor wires are run in conduit, as are also the wires in the basement; open and moulding work is used on the upper floors. Tungsten lamps are used throughout the entire building.

The chief engineer of this plant is James T. Wilde to whom the writer is indebted for assistance and information.

GASOLINE A PERFECT SOLVENT FOR OIL

SOME of the smaller units of two-stroke-cycle motors are being lubricated by mixing the lubricating oil with the gasoline. Objections are sometimes raised to this custom on the ground that the oil may settle in the fuel tank and cause trouble.

To prove that this cannot occur one may mix a teaspoonful of oil in a half pint flask with gasoline and allow it to stand for several days, when there will be no appreciable difference in density between the contents at the top and bottom. Gasoline mixed with oil is not any harder to vaporize than if unmixed, as the oil contained in it is not thoroughly vaporized, but is in the form of a mist and supported more or less by the air and gasoline vapor.—Ignition, Carburetion, Lubrication.

PIPE COVERING GUARANTEE

Buying on Specified Condensation Allowed with Performance Guaranteed, and Results of Tests

By D. J. Lewis, Jr.

WHEN the New York Rubber Co. decided to erect a new boiler house, the question was whether to place the boilers in the old location where it was necessary to haul the coal, or whether it was better to place it close to the coal pocket and carry the steam to the mill which meant exposed steam pipe of 200 ft., and about 150 ft. in the mill to the distributing point.

The latter plan was adopted and the boiler house was built on the bank of the creek immediately below the coal pocket, so that the coal could be handled by gravity.

The boiler plant consisted of 4 72-in.by 18-ft. boilers, with suspension setting, and set in a single battery, the piping connected as shown in Fig. 1. The pipes from each boiler were 6 in. in diameter and connected to a 12-in. header supported on the back wall of the house. From this a 10-in. steam pipe was taken vertically through the roof and connected by a long bend into the main line as shown on Fig. 2, carried on towers

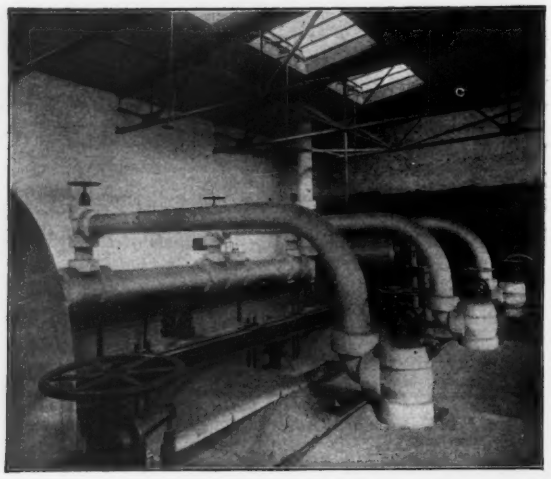


FIG. 1. BOILER PIPING IN NEW YORK RUBBER CO. PLANT

150 ft. to the store house, from this store house out doors for 50 ft., then into the mill and connected to a receiver from which the steam was distributed to the different parts of the mill.

As a guarantee was made with reference to the drop in temperature and pressure, the question of insulation was important, so that when the specifications were written for the covering the following clause was inserted:

"The covering will be of such thickness that with a temperature of 65 deg. F. on the inside of the building the condensation per square feet per hour will not exceed 0.17 lb. per sq. ft. on interior surface of the pipe. The covering outside of the building will be a proper thickness to give the same results in zero weather."

Another matter was the protecting of the covering so as to make it air tight and water tight.

The contract was let to the Armstrong Cork Co. for its Nonpareil high-pressure covering and installed in the following manner. Inside the mill the pipe was covered 2 in. thick. On the exposed piping it was covered 3 in. thick. The lengths of pipe on the outside were 50 ft. long locating each pair of flanges in the towers with hangers each side of the flanges so that the gasket could be renewed without disturbing the line.

Inside the mill the canvas covering was sewed on. Outside the canvas was cut in strips 6 in. wide and was wrapped spirally lapping the edges about 1 in., first in one direction then returning, making 2 thicknesses. This canvas was dipped in paint and after the whole was completed received 2 coats of bitumastic solution making it strictly air tight and water tight. The flanges were covered by building up with cement on wire mesh so that the cover can be removed and replaced.

After the steam pipe had been used for 3 weeks, a test was made to find out what the condensation would be. The part selected for this test was the main steam pipe leading from the boiler house to a receiver located in the mill. The amount of pipe tested was 346 ft. of 10-in. pipe, 198 ft. of which was exposed to the outside temperature at an average of about 25 ft. above the ground and supported on columns. The method of conducting the test was as follows:

Condensation from this pipe and the receiver was collected into a No. 24 Lytton trap which discharged into a receptacle located on a pair of scales, which receptacle was half filled with cold water and the end of the discharge pipe extended 8 in. below the surface of this water. When the water became heated enough to show vapor from its surface, it was discharged from the receptacle and replaced by cold water. The trap was a new one and tested for tightness before and after test, also after each discharge into the receptacle. The scales were balanced before and after each discharge, the intervals being on an average of about every 11 min. No re-evaporation of the discharge condensation was allowed to take place.

FIG. 2. EXPOSED PIPING BETWEEN BOILER HOUSE AND STORE HOUSE

Simultaneous readings were taken every 10 min. in the boiler house and at the receiver in the mill. Also

the temperature of the inside and outside air. All gages and thermometers were calibrated for the pressures and temperatures taken.

Test Results

TEST was run for 4.5 hr., while the factory was in operation, beginning at 10:15 a. m. and ending at 2:45 p. m. and the following is the result of the readings:

Surface exposed to outside temperature, sq. ft.	517.364
Surface exposed to inside temperature, sq. ft.	481.725
Total surface exposed, sq. ft.	999.089
Average steam pressure in boiler house, lb.	112.
Average steam pressure at receiver in mill, lb.	111.64
Average difference in steam pressure, lb.	0.36
Maximum difference in steam pressure at any one reading, lb.	1.
Average steam temperature in boiler house, deg. F.	341.51
Average steam temperature in receiver in mill deg. F.	341.03
Average difference in temperature, deg. F.	.48
Maximum difference in steam temperature any one reading, deg. F.	2.
Average temperature of outside air, deg. F.	27.66
Average temperature in mill, deg. F.	73.8
Total amount of condensation discharged by trap, lb.	568.
Average amount of condensation discharged per hour, lb.	126.
Average condensation discharged per sq. ft. of surface per hour, lb.	0.1261
Average condensation discharged per sq. ft. of surface per hour corrected for a temperature of 65 deg. F. in mill and zero outside, lb.	0.1361

During the test a Carpenter condensing calorimeter was kept in operation and at no time did the steam show any moisture. There were 3 boilers in operation during the test developing about 500 hp. The discrepancy in the thermometer readings of the average temperature and steam table temperature for the average pressure was probably caused by the wells, but both thermometers were of the same make and had the same kind of well so that this discrepancy shows at both ends making a result of drop in temperature correct.

These results show that in buying pipe covering, a reasonable specification of condensation can be asked and the guarantee met; and as cutting down condensation is the object of using pipe covering, this form of specification and guarantee seems logical to use.

HE IS THE BEST MAN MORALLY I KNOW IN THE WORLD

THAT is what one power plant superintendent says of his chief engineer—says it with conviction, says it truthfully, and says it after having known and worked with him for years and years.

It could not be said convincingly concerning a man who does careless work, who is unjust to his fellow workmen, who is dishonest with his employers, who is unreliable, who does not meet his financial obligations promptly, who is dissipated, who is a spendthrift, who is improvident, who is profane, or who is untruthful—and it would not be said of such a man.

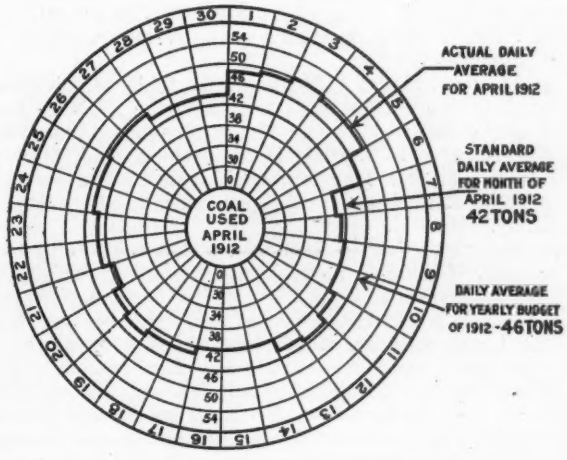
A simple statement, but a wonderful one, and a wonderful man he is of whom it can be said, "He is the best man morally I know in the world."—The Publicity Magazine.

OPERATING ENGINEER'S GRAPHIC CONTROL CHART

Record System Easily Kept Which Makes Comparison Easy and Aids in Analyzing Plant Costs

AS a rule the operating engineer is a busy man. He cannot afford the time, each day, to look up past records in order to compare with them the present records. He cannot afford to clog his mind by trying to remember figures from day to day. And yet he should be able to compare his records, he should be able to have within easy reach the necessary figures for comparison, and these figures should be so arranged that calculations are not necessary. They should show comparisons at a glance. The president of the Institute of Operating Engineers, J. C. Jurgensen, after carefully studying this problem, finally decided upon the graphic circular chart and the table, as shown herewith. The chart as shown is used every day, and proves one of the biggest helps in controlling both power and shops.

In order to explain the method of use and the application of this chart, there is shown a coal consumption curve for the month of April, with its table of figures. The table has 4 columns, one for the date, one for the tons used each day, one for the total tons used to date and one for the daily average to date. There are really 3 curves on the chart, the daily average as figured from the budget, the standard daily average and the actual daily average to date for the month.


ACTUAL DAILY AVERAGE FOR APRIL 1912
STANDARD DAILY AVERAGE FOR MONTH OF APRIL 1912 42 TONS
DAILY AVERAGE FOR YEARLY BUDGET OF 1912 - 46 TONS
COAL USED APRIL 1912

ENGINEER'S GRAPHIC CONTROL CHART

The budget is the amount of coal that is allowed for use in a certain period. By dividing the total tons thus given by the number of days in the period we secure the average which is marked "Daily average as shown by budget." If the employers do not specify a certain number of tons for a certain period then the chief engineer can fix his own budget and supply it as mentioned above.

It is the duty of every operating man to see how much he can save on the budget, and to do this there must be fixed a certain standard, adherence to which means such a saving The operating engineer after studying the conditions should fix a standard for his men to work by and to try and better it. This standard will vary from month to month, and should always be fixed after

a careful study of the records of the previous months of the period. It might be well to mention here that it is on the bettering of this standard that the payment of a bonus is often based. Now we have fixed 2 standards for everyday use, the standard as figured from the budget and the standard as figured from previous records in conjunction with the budget. The first is fixed once for each period, year or half year, as the case may be, and the second is fixed once for each month.

As soon as the chart is drawn up—and I usually have them drawn up in the office and not printed, although any of the recording instrument companies will print them for you—I put in the standards with red ink. Then I write in the amount of the standards, thus placing at hand all necessary data so that each time I look at the chart I can tell just how my daily consumption stands, as compared with previous records. The broken curve is for the accumulative daily average. It is plotted day

MONTHLY COAL RECORD OF PLANT

Date	Tons of coal used	Tons used to date for month	Daily average for month	Date	Tons of coal used	Tons used to date for month	Daily average for month
1	48	48	48	16	50	673	42
2	50	98	49	17	55	728	43
3	52	150	50	18	48	776	43
4	45	195	49	19	52	828	44
5	49	244	49	20	35	863	43
6	30	274	46	21	15	878	41
7	10	284	40	22	60	938	43
8	45	325	41	23	58	996	43
9	48	373	42	24	55	1051	44
10	51	424	42	25	58	1109	44
11	52	476	43	26	60	1169	45
12	60	536	45	27	40	1209	45
13	35	571	44	28	30	1239	44
14	12	583	42	29	46	1274	44
15	40	623	42	30	50	1324	44

by day from the figures in the table. Coal used for any day is entered opposite the date in the second column and added to the total in the third column, then the third column figure is divided by the date of the month, and the result is the accumulative daily average to date for the month.

After entering the figures in the table and drawing the daily line on the chart, we can see at a glance how the day's run was made. If the consumption was too high, if our daily average is creeping up, or if there is a large variance from running conditions, it becomes apparent and we can investigate and remedy it immediately.

The curve may be kept in any convenient unit; for instance, if there is no scale upon which to weigh the coal or ash we can keep the record in number of wheelbarrows or in number of cans of ash. There is one chart that I will mention, which lends itself very nicely to power plant work, and that is the chart upon which is plotted the tons of coal used per day, and also the tons of ash removed that day. By direct comparison we can see from this chart how the firemen handle the furnaces each day, and whether the coal is of a better grade or not, and by measuring the distance between the 2 curves we can find directly the number of pounds of combustible that were used.

Where there are 3 watches in each day's run, the space for days on the chart may be divided into 3 spaces, and the records of each watch plotted in these spaces, and then we can readily see the efficiency of each watch. We can apply this chart to cost of repair, cost of salaries, material used, hours machines were in operation, ash removed, coal used, oil used, average loads, water used, and in many other ways. Once you learn to keep and study your records, from the chart as described, you will find many ideas for its use springing up, and you will be surprised how, by a small amount of watching and studying, the costs will be kept lower, and better results obtained without going to the expense of purchasing elaborate instruments and hiring men to tend them.—Bulletin of Institute of Operating Engineers.

SUGGESTIONS FOR ECONOMICAL POWER PLANT OPERATION

Points to be Watched for Leaking Power

By Wm. Kavanagh

ECONOMY in the use of fuel and electric current is an essential factor in securing satisfactory financial results in a power plant. From a practical standpoint the fireman is expected to burn the least amount of fuel consistent with the demand for steam. Expert firemen are often handicapped in the economical use of fuel either through the penuriousness on the part of the management of the plant or through the inefficiency of the engineer. Where bad management exists a poor equipment is usually found, which of necessity entails a loss which is also true where an inexperienced engineer is employed.

It is evident, therefore, that the realization of economy does not depend on the fireman or engineer individually. The efforts of both the engineer and the fireman to produce cheap power can be easily nullified if the management of the plant is not watchful in preventing waste of light, heat and power. It would at first appear that the management of a factory or a building could not assist in producing cheap power, but if the matter is investigated it will be learned that proper supervision is an important factor in producing such a result.

If power is economically generated the engineer and fireman have properly performed their part of the work. The next question that arises is how the power is being used. In many instances it will be found that a large number of incandescent lamps are blackened and as such lamps give a small amount of light in proportion to the current consumed it is poor economy to let them remain in use. The management, however, will probably object to the buying of new lamps as long as the old ones continue to burn. In other instances motors may be found running idle for no apparent purpose, and again electric heaters, glue pots, and soldering irons, may be found consuming current when not in use. It is not an uncommon occurrence to find lamps burning where they are not needed and wires lying on steam and water pipes causing leakage of current. When such conditions exist the economical generation of power is of little avail.

Other sources augmenting the loss in power which are hard to detect, are tight belting, poorly oiled shafting and motors. Belting that is stretched beyond normal requirements is one of the greatest consumers of power. An inexperienced person will invariably tighten a belt when in reality it should run slack, which is a feature with which many persons are not familiar.

A belt will waver on the pulling side when it is excessively tight and conversely it will waver on the slack side when it is too loose. If the wavering occurs on the pulling side, the belt should be slackened until the wavering ceases. The tightness of a belt can also be determined from the temperature of the shaft bearing to which the pulley is attached. If a bearing is well oiled and is found above normal temperature it indicates that the belt is too tight and should be slackened.

Other conditions, such as the temperature of the room and the condition of the atmosphere cause tight belts. If the atmosphere is damp canvas belts will tighten and if the atmosphere is dry they will run slack. With leather belts the reverse conditions are

true. Leather belting should be oiled occasionally with some high grade oil to keep it soft and pliable. If canvas belts are leather lined, the lining should be oiled to prevent cracking or splitting.

When motors are not properly cared for and are allowed to spark, an unnecessary waste of current is the result, which is also true if the motors have to run in a high temperature without being ventilated. The ventilation of motors is an important factor in reducing operating expenses.

During the cold season the cost of fuel necessarily increases and this increased cost is proportionate to the system employed for the distribution of heat throughout the plant. Where a modern system of heating is used the cost for extra fuel will be decreased to a large extent.

DISPERSING A CROWD

CERTAINLY we all ran. Who wouldn't with a big flange joint letting go and opening up a crack an inch wide through which scalding steam was pouring. But if we hadn't been too scared to stop to look, I doubt if we could have run for laughing at "Spuds." Afterwards we did laugh, Spuds as well as the rest, although he lost a good part of the fun because he couldn't see the figure that he cut at the time.

Spuds? Oh, yes. He was our court jester back at the Chop Sawey camp along in the eighties, where I was acting as go-between for the natural resources in the sawdust pile and the ultimate consumer in the boiler shed. If any one had ever known his real name it had been forgotten for the monicker fitted so completely that any formal label was superfluous. Even the dapper little pay clerk who came in once a month to distribute coin of any old realm that he happened to have had given up calling Mr. Er-Er-Er—and Spuds marched with the S's in the columns of the alphabetical payroll.

What does it mean? Why "spud" is yankee for potato, and, did you ever see the dolls that the farmer's kiddies make with a big potato, a little potato and 3 twigs. Spuds was a kodak reproduction of one of those dolls; bullet head, bulgy body, spindly legs, and all latitudes severely foreshortened.

But he was long on good nature and story telling, particularly in regard to his own dare deviltry in the face of danger. When not otherwise occupied, his favorite perch was on a stool just inside the boiler shed door— stool which was especially created as a resting-place for the weary bones of the sawdust conveyor—meaning myself—between seasons of driving my horseless wagon to and fro from slab pile and dust pile to the fiery furnace. No effort to "save the coal pile" there. It was a case of burn it to get rid of it; and when it didn't disappear fast enough, wheel it to a dump pile just outside the shed door as a "reserve," although why they wanted to reserve it no one could ever explain.

This reserve pile was the contributory cause of the whole happening, for the plant being on uneven ground, there was a steep slope just there and the sawdust formed a soft incline to the bottom where there was usually a none too fragrant pool. The drop was some 20 ft.

The chief was a genius for devising original ways of doing things, sometimes workable, often not, but he was always trying to do "somethin' diffrunt."

Considering the condition of the plant he was not to be blamed for that. As an example, there were 2 boilers each with a steam dome and to connect them a flange had been bolted to each dome, the 2 flanges facing each other. A straight pipe was run between with a flange union to make a joint; but due to miscalculation or settling or expansion the joint stood open about an inch when unbolted, so that it was a bad job to draw it together.

Here was a chance for a "kink." Just cut a nice shim of poplar board and insert it between the flanges. A brilliant idea; also different. And it was duly done.

It is conceivable that a good tough piece of oak, or even a piece of maple might have held for a reasonable amount of time, but in the case of the soft poplar, as soon as the hot steam and water began to drip back and forth through the pipe, the inherent cussedness of material things got busy and the wood began to give. What chance has a poor wet piece of soft poplar got against a heavy steam pressure? It stuck manfully to its job and held out as long as it could, but about 10 o'clock Monday, when behold Spuds in royal state, seated on his favorite throne, chewing the rag as usual, and telling about some of his extremely dare-devil exploits with redskins, polar bears, log jambs, etc., I was standing around resting my legs by holding up the side of the boiler shed and making an effort to appear politely interested.

All of a sudden kerwhoosh she went, and that patent all-wood natural finish, joint packing let go with a pop like a half dozen safety valves at once. Certainly, we all RAN!! If you had been there you would have done the same. The fellow who got farthest was simply the fellow who could run fastest, but as we jumped in every possible direction, Spuds fell off the stool, made one wild leap out of the door, and in doing so managed to catch his foot and drag the stool down on top of him.

It was an even race between Spuds and the throne to the bottom of the slide. First Spuds got a little way ahead, then the throne caught up and butted him along, so they went until with a far spread splash the whole combination finished up in a cooling, if inglorious bath, at the bottom, whereupon Spuds began a wild struggle to keep his head above water, and climbing up on the stool called wildly for help.

From our safe vantage points at the various distances that we had reached, we stopped at the sound of these shrieks, turned and beheld the spectacle. Steam was still issuing from every opening of the boiler shed, but as someone had by this time explained what the difficulty was, no further apprehension was felt, and it was a case of wait until the pressure blew down.

Meanwhile, someone with either a bigger sense of humor or sympathy than the rest, went to the rescue of Spuds, and hailing him from the dry bank of the pool, remarked casually, "Shut up your yelling, and come out of that."

Then broke out Spuds, "Am I in the river? How high did I go? How far did it carry me? Is everybody killed?"

Then came the real explosion, and poor Spuds didn't hear the last of his brave retreat from the place of danger, and the charge of steam, so long as he stayed around that camp, but whenever his tendency to draw the long bow got the better of him, someone casually remarked, "Been down to the old swimmin' hole lately?" and Spuds would retire to the deep background.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

CONCEALED WIRING*

Practical Suggestions for the Installation of Knob and Tube Work in Frame Buildings

By Arthur O'Brien

FIXTURE outlets are shown in Figs. 4 and 5. For an electric fixture a cleat, consisting of a piece of board at least 7/8 in. thick, should be nailed between the joists or studs into which the wood screws supporting the electrolier can be secured. Holes are then

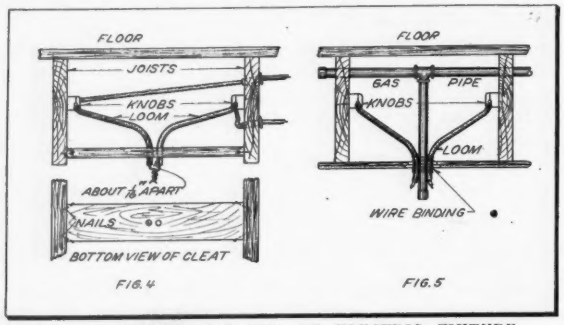


FIG. 4. OUTLET BOX FOR AN ELECTRIC FIXTURE
FIG. 5. FLEXIBLE TUBING PROTECTION AT A COMBINATION FIXTURE OUTLET

bored through the cleat, through which the flexible tubing can pass. With a combination gas and electric fixture no cleat is necessary, because the gas pipe supports the fixture. The flexible tubing should be wired, iron wire

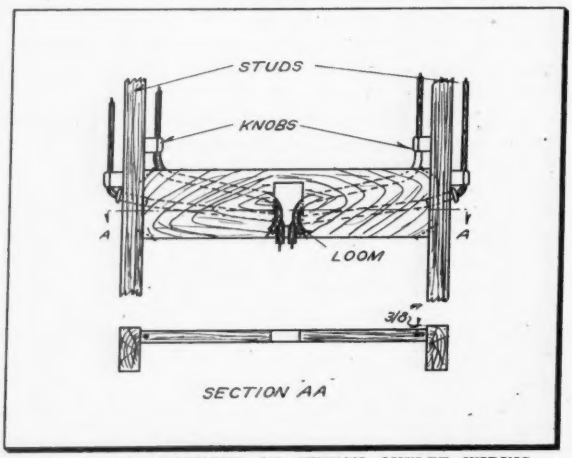


FIG. 7. ARRANGEMENT OF SWITCH OUTLET WIRING

will do, to the gas pipe, to prevent displacement by artisans that have occasion to work around the outlet.

In wiring for switches, flexible tubing must be used on the conductor ends from the last porcelain support, as shown in Figs. 6, 7, and 8, the same as on conductor ends for other outlets. A pressed steel switch box should be used to encase each flush switch mechanism, even though it already be encased in porcelain. A 7/8 in. wood cleat or cleats are arranged to support the switch box. These wooden cleats should not be set out flush with the

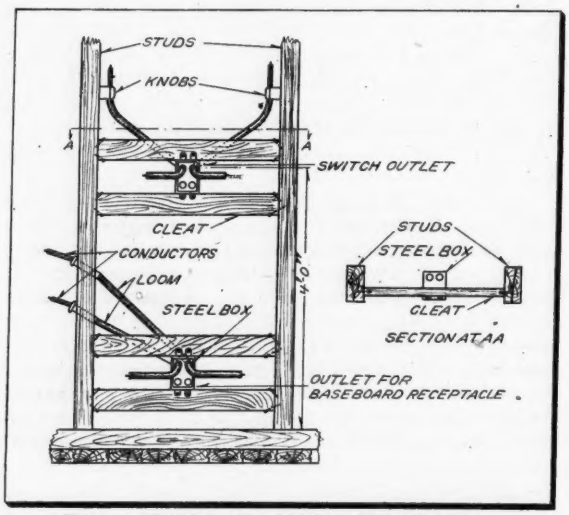


FIG. 6. SWITCH AND RECEPTACLE OUTLETS

outer edges of the studs, but should be set about 3/8 in. back, as illustrated, to allow a space in which the plaster can take a "grip."

For a surface snap switch outlet shown in Fig. 8, an iron box is not necessary, but a 7/8 in. cleat must be installed to hold the tubing in place and to provide a proper support for the screws that hold the switch. In wiring old buildings where supporting cleats were not provided

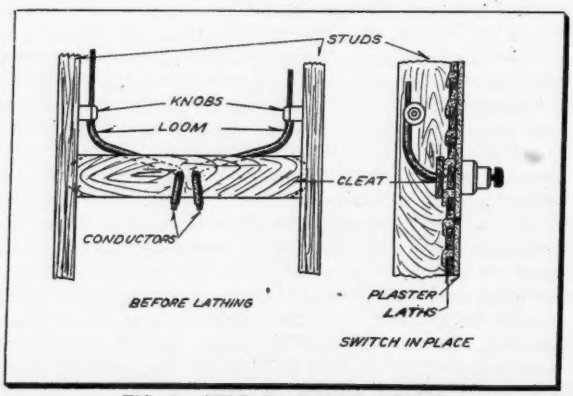


FIG. 8. SURFACE SWITCH WIRING

*Continued from page 883 Sept. 1 issue.

back of the plaster, a ¾ in. wooden block or plate should be installed on the surface, to which the switch can be attached.

Steel switch boxes for flush switches are formed from sheet steel, as shown in Fig. 9. A single switch box can be expanded for any number of switches, by using the proper number of spacers. Single and double switch boxes can be supplied already assembled and are used

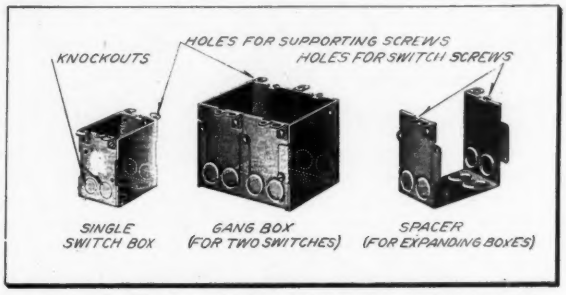


FIG. 9. SWITCH BOXES FOR KNOB AND TUBE WIRING

where feasible, because it is cheaper to buy them this way than to assemble them on the job. Holes partially punched, which can be knocked out with a hammer blow, are provided in the sides and back through which the flexible conduit wire protection can be extended.

Figures 10 and 11, giving dimensions of standard porcelain tubes and knobs, will be found in the Practical Reference Tables.

STEAM ELECTRIC POWER PLANT*

What Each Part of a Steam Turbine Driven Plant Should Cost, and Should Produce

By O. S. Lyford, Jr. and R. W. Stowel

UNDERLYING the design, construction, and operation of all power plants is the requirement that the plant shall produce a given amount of useful power, under imposed conditions, for a term of years and for the least total cost. The study of costs therefore becomes the key to the design of a power plant for any purpose.

In comparing plant costs, the unit used is the kilowatt capacity of the generators installed. The figures given in Table 1 are based on the maximum continuous capacity of the generator, or the output that the machine will give with a temperature rise not exceeding 90 deg. F. above the surrounding air temperature. Only one class of stations is referred to in computing the probable cost limits, namely, steam-turbine driven electric stations for all purposes, using bituminous coal for fuel and containing no other equipment except that necessary for the efficient generation of alternating electric current.

Such group costs as "Preparing Site," "Yard Work," "Electrical Switching Equipment," and "Service Equipment" have no very specific relation to the kilowatt capacity but are more a matter of experience in previous cases.

As a general proposition, if sufficient room is allowed around the apparatus for proper operation, no benefit is obtained by adding more space; therefore, the actual cost of the real estate makes practically no difference in the design. But the location with reference to fuel and water supply and the physical condition of the property materially affect the cost. In consideration of alternative sites the cost of the "Yard Work" may have an important bearing.

Foundation costs, which will run from $1.25 to $4 per sq. ft. of building plan area, are governed chiefly by the bearing value of the soil, as the necessity for rock excavation or piling may add $2 to $3 per kilowatt. The plan area will vary from 0.8 to 1.5 sq. ft. for each kilowatt of capacity installed, depending on the size of the units and upon their arrangement, the combined effect of these two cost ranges giving the range in price per kilowatt

In regard to the building itself, the cost will vary from 8 to 12 cents per cu. ft. of building volume according to the building, the construction, and the price of materials. Depending again upon the size and arrangement of the units, there will be required from 50 to 100 cu. ft. of volume per kilowatt of capacity. These combined effects give the cost range shown in the table.

In boiler room equipment, the cost of labor and materials will generally be between $30 and $40 for nominal boiler horsepower and there will be installed between 0.4 and 0.6 boiler horsepower per kilowatt of capacity, which gives the range in cost.

TABLE I. COST OF STEAM TURBO-ELECTRIC GENERATING STATIONS

From 2,000 to 20,000 kw. capacity, based on maximum continuous capacity of generators at 50 deg. C. rise

	DOLLARS PER KW High	Low
Preparing Site—Dismantling and removing structures from site, making construction roads, tracks, etc.	$ 0.25	$ 0
Yard Work—Intake and discharge flumes for condensing water, railway siding, grading, fencing sidewalks, etc.	2.50	1.00
Foundations—Including foundations for building, stacks and machinery, together with excavation, piling, waterproofing, etc.	6.00	1.00
Building—Including frame, walls, floors, roofs, windows and doors, coal bunker, etc., but exclusive of foundations, heating, plumbing and lighting	12.00	4.00
Boiler Room Equipment—Including boilers, stokers, flues, stacks, feed-pumps, feed-water heater, economizers, mechanical draft and all piping and pipe covering for entire station except condenser water piping	24.00	12.00
Turbine Room Equipment—Including steam turbines and generators, condensers with condenser auxiliaries and condensing water piping, oiling system, etc.	22.00	12.00
Electrical Switching Equipment—Including exciters of all kinds, masonry switch structure with all switchboards, switches, instruments, etc., and all wiring except for building lighting	5.00	2.00
Service Equipment—Such as cranes, lighting, heating, plumbing, fire protection, compressed air, furniture, permanent tools, coal and ash handling machinery, etc., etc.	5.00	2.50
Starting Up—Labor, fuel and supplies for getting plant ready to carry useful load	1.00	0.50
General Charges—Such as Engineering, Purchasing, Supervision, Clerical Work, Construction Plant and Supplies, Watchmen, Cleaning up, etc., etc.	6.00	3.00
Total cost of plant, except land and interest during construction	$83.75	$38.00

The principal factor in the cost of turbine room equipment is the size and speed of the main generating units; the higher the speeds the less the first cost of the apparatus. Another factor is added, in the type of condenser used. As a surface condenser installation will cost from $1 to $3 a kilowatt more than the mixing type, the warrant for it must be thoroughly established. The selection between these two types depends upon the suitability of the condensing water for use as feed water. As a general statement, if the cost of feed water does not exceed 6 cents per 1,000 gal., and if the average load on the plant does not exceed ½ the maximum load, then surface condensers are not warranted. A noncondensing station is no longer commercially feasible

*Condensed from a paper read before the Engineers' Society of Western Pennsylvania.

except where there is a large requirement of exhaust steam for heating, for the reason that a steam turbine takes from 50 to 70 per cent more steam when running noncondensing and the first cost of the extra boiler capacity necessary generally exceeds the cost of condenser installation.

The cost of electrical switching equipment depends directly upon the character of service in which the current is used.

The item of coal handling is the largest variable cost factor in service equipment, necessary storage facilities being governed by the distance the plant is located from the coal supply. Mechanical handling devices are a distinct economy in most cases.

TABLE II. BOILER ROOM EQUIPMENT COSTS PER RATED BOILER HORSEPOWER; USING COAL FOR FUEL

	DOLLARS PER HP High	Low
Boilers exclusive of masonry setting	$11.00	$ 8.00
Superheaters	3.00	0
Stokers	5.50	3.00
Masonry settings for boilers	3.50	2.00
Flues	1.50	0.75
Stacks	4.00	2.00
Economizers	4.00	0
Mechanical Draft	3.00	0
Feed-Pumps	1.50	0.50
Feed-Heaters	1.00	0.40
All Piping and Pipe Covering	10.00	6.00
Coal Chutes and Ash Hoppers	1.25	0
Various, such as Indicating and Recording Devices Damper Regulator, Ladders and Runways, Painting, etc., etc.	1.00	0.50
Totals	$50.25	$23.15

Note—The above costs are for labor and material only. They do not include any "General Charges" such as Engineering or Supervision. The piping item includes all piping in the entire plant except condenser water piping.

Table II shows the unit costs of boiler room equipment in relation to rated boiler horsepower. The cost per kilowatt will vary according to the proportioning of the boiler capacity to the generator capacity.

The use of larger boiler units, the tendency to make a given amount of boiler surface develop more power, and the use of superheat are all factors which have resulted in increased economy as compared with former conditions. Several years ago it was defined that 10 sq. ft. of heating surface should constitute 1 hp. in the rating of a boiler. With the gradual development of mechanical stokers and an increased knowledge of coal combustion, it is now customary to demand boilers, from 150 to 200 per cent of their rating. With this practice we have practically cut in half the boiler group cost.

TABLE III. SUMMARY OF OPERATING RESULTS

	Range of Common Practice	
British thermal units per pound of fuel (assumed)	14 000	
Average yearly overall boiler and furnace efficiency %	50	70
Effective British thermal units per pound of fuel	7 000	9 800
Boiler pressure, pounds per square inch, gauge	125	190
Superheat, degrees Fahrenheit	0	125
Average feed-water temperature, degrees Fahrenheit	120	200
British thermal units per pound of steam (approximate)	1 100	1 100
Pounds of water evaporated per pound of fuel, actual	6.36	8.91
Pounds of fuel per standard boiler hp (33 305 B. t. u's.)	4.76	3.40
Average overall station water rate per kw	30	20
Pounds of coal per kw generated	4.72	2.25
British thermal units in coal per kw generated	66 000	31 500
Thermal efficiency of station, percent	5.2	10.8

The use of superheat ranging from 100 to 150 deg. F. will improve overall efficiency of a plant from 5 to 7 per cent, and superheaters will generally result in overall economy, even with coal as low as $1.50 per ton.

Economizers have also proved their efficiency. It may be stated roughly that with 50 per cent annual load factor and coal costing $3 or more per ton, the saving in heat with the economizers is enough to cover more than their fixed charges and maintenance.

With increased boiler pressures and superheat, there has followed a decrease in pipe sizes. Whereas, formerly an 8-in. pipe would be used on a 500-hp. boiler running not much over rating, a 6-in. pipe is now used on a 600-hp. boiler and 1200 hp. taken through it. An important feature of steam piping is the pipe covering. It pays to provide a good covering which may easily be removed and replaced at a small cost, where repairs are necessary.

Indicating and recording devices, such as draft gages, recording thermometers, gas testing apparatus, coal and water weighing devices, have become necessities in the large boiler plant and save their cost many times, regardless of the price of coal.

Table III shows the range of common practice in coal consumption. Pittsburgh coal of 14,000 B. t. u. per pound is assumed in both cases. Better overall results than the best here shown have been obtained in rare instances of large stations or exceptionally good load factors, but it is not often that conditions permit present day equipment to exceed the high figure shown. Cases which fall below the minimum are sometimes logically due to the small size of the plant or character of the load, but in some cases, improper design, or lack of knowledge on the part of the operating force is the cause of poor results.

RATING ELEVATOR MOTORS

Power Required to Run Elevators at Various Speeds With Different Loads

TO lift a certain load, the power an elevator motor must develop depends upon the speed at which the car is to travel. The actual horsepower must be larger than the theoretical because of the losses due to friction in the gear mechanism. The rating of a motor with regard to actual conditions is given by the relation:

$$\text{Horsepower} = \frac{\text{Car Load in lb. x ft. per min.}}{33000 \times \text{Efficiency \%}} \times 100$$

Efficiency of elevator machinery varies from 50 per cent to 70 per cent; it should be increased by any means, such as is afforded by the application of ball-bearings, or by greater accuracy in gear cutting. On the basis of an efficiency of 60 per cent the curves shown in Figs. 1 and 2 in Practical Reference Tables were derived.

The above formula does not take into account the effort necessary to start the load from rest, and if the formula alone were used, one is liable to select a motor too small for the conditions; frequently the starting torque in pounds pull at 1 ft. radius together with the speed of the motor, is specified. It then becomes necessary to select the motor by the torque it will develop. As mentioned above, an elevator motor should have a starting torque of 275 per cent of synchronous torque.

Curves are used by courtesy of the Ideal Electric & Mfg. Co., Mansfield, Ohio.

OUR SPECIAL SOURCE of amusement in the plant is Jan Jensen. He always has an original reason when things go wrong, which is not infrequently, much to the disgust of the chief. He is knight of the coal scoop, but does not always give his entire soul to keeping up steam and the dropping pressure results in visits of the chief to the boiler room with loud and long protest. At one time the injector and part of its pipe had boasted a covering, but most of this had gradually faded away, and after a stormy interview, Jan remarked: "That water shooter lost most of hees yacket. He makes those water too cold to make good steam."

PRACTICAL ELECTRICAL ENGINEERING

In This Article is Explained How Magnetic Lines of Force Are Set Up Around a Conductor and How Conductors Attract and Repel Each Other. The Characteristics of a Helix Are Given and Different Types of Electro-Magnets Are Illustrated and Described

IF a current of electricity is passed through a conductor there are magnetic lines of force set up about it. These assume a circular form and surround the conductor as shown in Fig. 1, which is a cross-sectional view. There is a definite rule governing the direction which these lines assume.

Assume that current in the conductor shown in the figure is flowing downward through the paper or in a direction away from the observer, then the lines of force

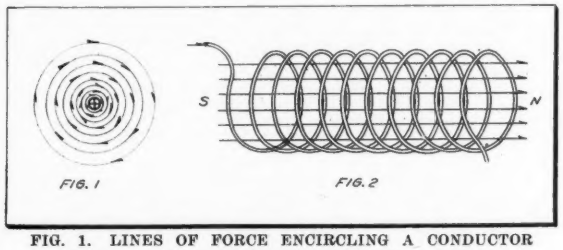


FIG. 1. LINES OF FORCE ENCIRCLING A CONDUCTOR
FIG. 2. LINES OF FORCE THROUGH A HELIX

will have the polarity in the direction of the hands of a clock. Conversely, if the current flows toward the observer, then the lines will assume a counter-clockwise direction of polarity.

Figure 2 represents a coil of wire or helix. If a current flows through this helix lines of force or magnetic flux will be set up through its center. Figure 3 represents 2 conductors in which the current is traveling in the

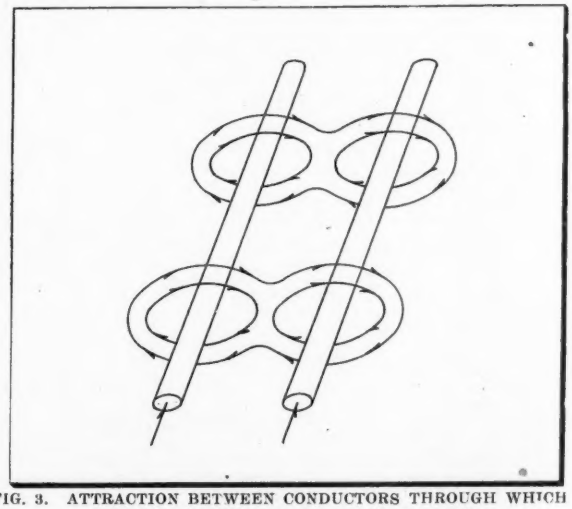


FIG. 3. ATTRACTION BETWEEN CONDUCTORS THROUGH WHICH CURRENT PASSES IN LIKE DIRECTIONS

same direction. Under such conditions mutual attraction exists between lines of force surrounding these conductors owing to their unlike polarity and if there were a large number of conductors there would be practically a continuous stream of lines over side and back on the other side.

This phenomenon is present in the helix but in this case the lines do not all return over the surface of the wire but spread out, part returning through the air as in the case of a bar magnet forming distinct poles at each end.

If the current through the helix is in the direction of the hands of a clock, when the observer is facing the end the lines will be directed away from him forming a north pole at the far end and a south pole at the near end.

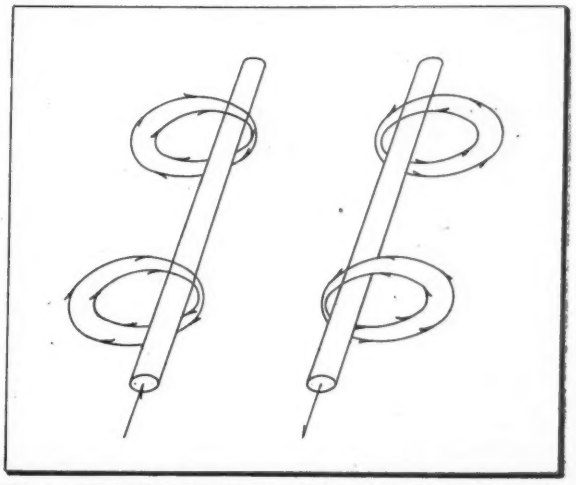


FIG. 4. REPULSION BETWEEN CONDUCTORS THROUGH WHICH CURRENT IS PASSING IN OPPOSITE DIRECTIONS

If a core of iron or steel be placed in one end of the helix when a current is flowing, the magnetic force will tend to draw it inward. The magnetomotive force which tends to set up lines of force will then act through the iron or steel core, and the number of lines be greatly increased as the magnetic resistance of iron or steel to passage of lines is much less than that of air.

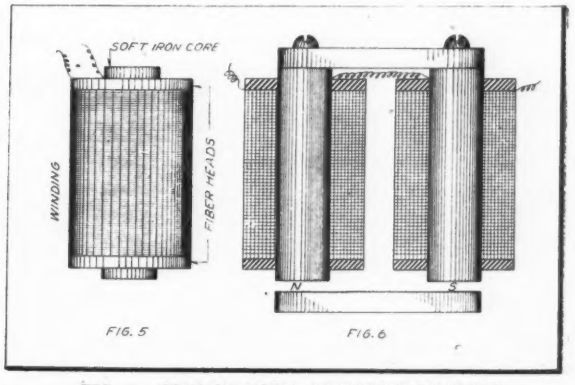


FIG. 5. COMMON FORM OF ELECTRO-MAGNET
FIG. 6. USUAL METHOD ON COMBINING ELECTRO-MAGNETS IN PAIRS

It has been pointed out that the lines of force surrounding conductors in which the current is flowing in the same direction mutually attract. Conversely, if the current in the conductors flows in opposite directions the lines of force will repel each other as shown in Fig. 4.

Figure 5 illustrates an electro-magnet. It consists of a soft iron core with fiber heads forming a spool which is wound with insulated copper wire. When a current flows

through the winding the core becomes magnetized and its behavior is the same as a permanent magnet so long as the current flows. When the current ceases the magnetism also ceases, with the exception of what little residual magnetism remains.

It has already been noted that magnetism always makes a complete circuit and to reduce leakage and secure the full effectiveness of electromagnets the common method is to use them in pairs secured to a cross piece of soft iron as shown in Fig. 6, the magnet cores cross piece and armature forming the magnetic circuit. This arrangement of magnets is largely used and is well illustrated in the telegraph instrument, electric bells, etc.

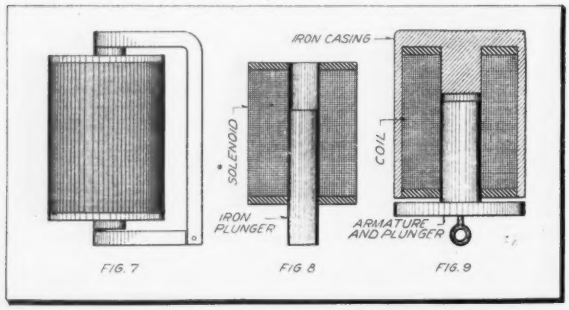


FIG. 7. SINGLE ELECTRO-MAGNET WITH IRON SUPPORT FOR ARMATURE, COMPLETING THE MAGNETIC CIRCUIT
FIG. 8. SOLENOID OR PLUNGER TYPE MAGNET
FIG. 9. IRON CLAD PLUNGER MAGNET

Single electromagnets may be used with good results if the magnetic circuit is completed by an iron angle piece to which the armature is attached as shown in Fig. 7.

Plunger magnets are largely used in many kinds of electrical instruments; Fig. 8 shows such a magnet. It consists of a spool of wire called a solenoid in which an iron plunger is free to move. The plunger normally projects from the coil but when current is flowing through the winding it is drawn into the coil actuating any mechanism to which it is attached. To increase the efficiency and provide a magnetic circuit for a plunger magnet it is frequently iron clad as shown in Fig. 9.

A PLOWED FIELD IS A 100,000 VOLT TRANSMISSION-LINE CONDUCTOR

ONE of the No. 0 hemp-center stranded copper wires of the Central Colorado Power Company's 100,000-volt transmission line from its Boulder plant into Denver broke at the center of a 500-ft. span 2 miles from the city April 14, allowing the 2 ends to fall to the ground in a plowed field. It was then 1 a. m. and the system was carrying 3700 kw., but the ground connection thus established continued to carry the load without incident for 7 hr. During this time one of the wires finally burned back to the point where it hung suspended from the tower insulator, thereby setting up a series of arcs between wire and ground and causing surges which attracted the attendants' notice by the swinging of the station-instrument needles.

When the trouble was located, between the towers the No. 0 stranded conductor was found in the shape of a number of short sections averaging 6 in. in length, and below the end of each was a cone-shaped fulgurite in the clay soil, where the earthy matter had been fused to a mass of slag. As each section of conductor burned off the live end left had apparently established a new point of contact about 6 in. from the end, where it was in turn severed.

Some of the fulgurites or slag masses measured 8 in. in diameter at the top, tapering to 2 in. at the tip 18 in. below the ground, and the surface of each was covered with numerous little spines or roots, apparently marking the points where the current entered the surrounding earth. In other places the fused mass lay in the direction of the line, and for several feet around this path the ground was too hot to stand upon, even 3 hr. after the current had been shut off. Since the accident the field has been replowed, bringing to light numerous sections of the once molten, glassy path which joined the conductors. The cause of the span breaking in the center was traced to an unraveled strand in the ground wire which had dropped down on to the line conductor, thus burning the latter in two.—Electrical World.

NEW MOTOR STARTER

Simple d. c. Motor Starter Equipped With All Necessary Protective Devices

ACCOMPANYING illustrations show a d. c. motor starter fully equipped with all necessary protective devices and yet remarkably simple in construction and operation. The magnet switch serves to open and close the circuit and its blow out coils prevent injurious arcing.

In conjunction with interlocks and the overload-relay this switch also affords low-voltage and overload protection. The 2-pole line switch serves to disconnect the motor and starter from the line completely; the multipoint starting switch serves to cut out the starting resistance in several steps. This switch has an interlock contact at each end, one of which must be closed before the magnet switch can operate.

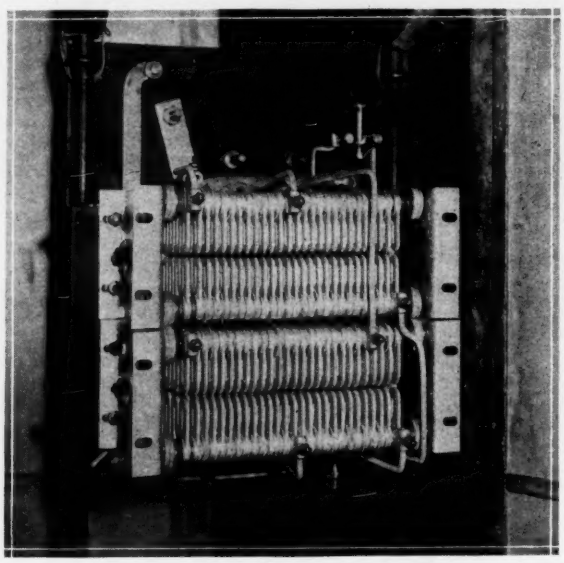


FIG. 2. REAR VIEW OF MOTOR STARTER

With the starting switch wide open, the operator closes the line switch and then closes the starting switch step by step while he holds its upper interlock closed. Owing to the action of the 2 interlocks he cannot start until all of the resistance is in circuit nor can

he leave the motor operating with part of the resistance still in circuit. When closed the starting switch holds the upper interlock closed.

An overload either while starting or while running operates the relay, causing the magnet switch to open the circuit. Failure of voltage also opens the magnet switch. In either case the starting switch must be completely opened, placing all the starting resistance in circuit before the motor can again be started.

To stop the motor, it is only necessary to pull out the starting switch enough to release the upper interlock. The circuit would then be opened by the dropping of the magnet switch.

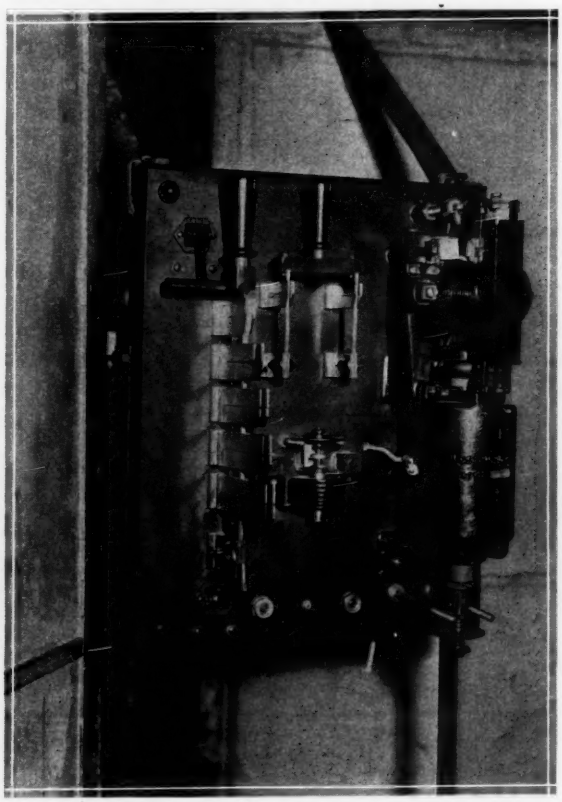


FIG. 1. SIMPLIFIED D. C. MOTOR STARTER

All the switches, relays and interlocks are compactly mounted on a slate panel which is provided with supports suitable for floor mounting. In most cases the starting resistor is mounted on the rear of the panel, but when large and heavy is separately mounted.

This device affords a neat, safe, efficient and inexpensive method of starting and protecting constant speed direct current motors. It is manufactured by the Westinghouse Electric and Mfg. Co., and is known as the type S Starter. Capacities are suitable for 115-volt motors of from 10 to 60 hp., 230-volt motors of from 12½ to 125 hp., and 550-volt motors of from 30 to 250 hp.

DON'T BE A WOBBLER. If you think a thing, think it strong enough to live it, even though you may be too wise to argue about it.—Triumph Chronicle.

BURSTING POINT OF PIPE

GENERALLY accepted formula for calculating the bursting point of pipe of given thickness is:

$$BP = \frac{2T \times TS}{D}$$

in which BP=Bursting pressure
T=Thickness
D=Diameter
TS=Tensile strength of material.

Example. Find the bursting point of 10-in. full weight pipe 0.366 in. thick, internal diameter 10.019 in. tensile strength of metal 50,000 lb.

$2 \times .366 = .732 \div 10.019 = .073 \times 50{,}000 = 3{,}653$ lb.

(2) The bursting point being given, the formula for thickness of metal will be:

$$T = \frac{DP}{2TS}$$

Example. Find the thickness of metal required in a 10-in. pipe 10.019 internal diameter, to burst at 3,653 lb., the tensile strength of the metal being 50,000 lb.

$10.019 \times 3{,}653 = 36{,}599 \div 100{,}000 = .366$

Value of TS. It is better to assume the tensile strength of steel pipe at 50,000 lb. and of wrought iron pipe at 40,000 lb., although the metal is, in reality, stronger than that.

Factor of Safety. The proper factor of safety to be employed is a matter of judgment, but for steam piping it never should be less than 10 and perferably more. In steam lines there are stresses due to vibration, expansion and contraction, and possible shock. In water lines there may be severe shocks due to water hammer or the less severe but continual shocks from the action of the pumps. The possibility of corrosion has to be considered also, as in some cases the original thickness of the metal may be reduced ½ in a comparatively short time. As these disturbing elements can only be assumed, it is evident that high factors of safety may be employed with advantage.

The foregoing rules are theoretically correct, but tests made by Crane Co. go to show that the average results are too high, and the company strongly advises using a very liberal factor of safety, especially on lines carrying steam or compressed air. Some time ago the company made bursting tests on 10-in. pipe with the following results:

10-in. Standard Wrought Iron burst at 1,900 lb.; by rule, 2,922 lb.

10-in. Standard Steel burst at 3,000 lb.; by rule, 3,648 lb.

10-in. Extra Strong Wrought Iron burst at 2,700 lb.; by rule, 4,102 lb.

None of the pieces destroyed burst at the weld, the rupture in each case being some distance from it. Table given in the Practical Reference Tables is worked out according to the formula.—The Valve World.

BY PLACING A HORSESHOE or bar magnet close to an incandescent lamp it is easy to determine whether alternating or direct current is being used. If direct the filament will be attracted or repelled, while if alternating it will vibrate rapidly.

BY connecting a short wire from each terminal of a circuit or a storage battery and immersing the ends in a jar of water in which has been dissolved a handful of salt the positive and negative poles can be determined. The larger bubbles will be produced at the positive connection, those at the negative being much smaller.

PRACTICAL MATHEMATICS

Notation and Decimal, Practical Examples in Addition, Subtraction, Multiplication and Division of Decimals

IN our system of writing numbers, each figure represents a unit 10 times the value of that represented by the figure next to the right. That is, if we write the number 25, the 2 represents 2 tens and the 5 represents 5 ones, and the same rule holds for figures either to the left or the right. After we have come to the unit or one's place, however, we put a decimal point which is shown by the line A in Fig. 1 and to the right we are subdividing into fractional parts. The next figure to the right of the decimal point representing one-tenth, the second figure to the right of the decimal representing one-hundredth and so on. That is in every case a figure to the right represents a unit, one-tenth that of its left-hand neighbor.

The names that we give to the different units are as indicated in Fig. 1, those to the left of the decimal point running up by tens, hundreds, thousands and so on, and those to the right of the decimal point running by tenths, hundredths, thousandths and so on. There is really no difference in the arrangement or values of the numbers to the left or the right of the decimal point except that in whole numbers the decimal point is always understood to be the right of the last figure while in decimals the decimal point should be to the left, and any number of ciphers may be inserted between the left hand figure and the decimal point to indicate the size of the unit represented This relation is illustrated by Fig. 1, in which each square represents the position that may be occupied by a figure and the name represents the unit which this figure would signify.

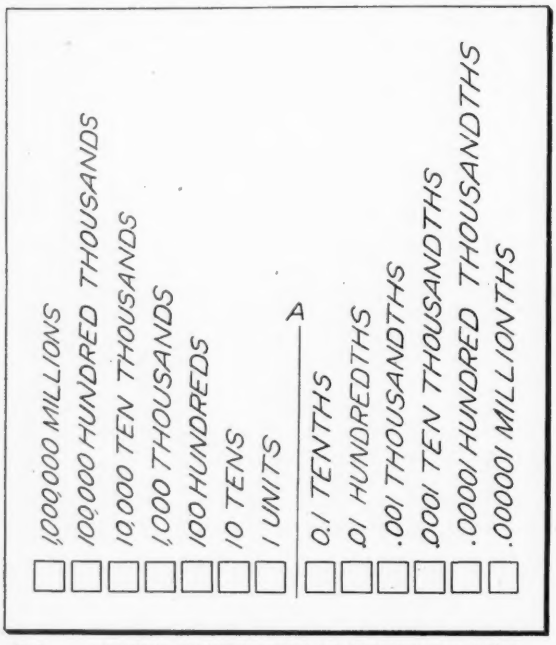
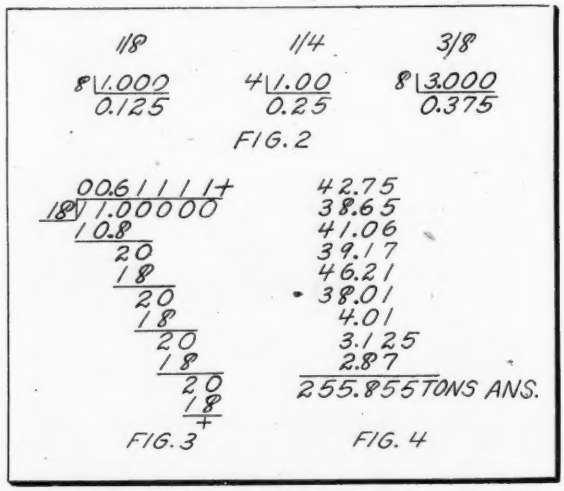


FIG. 1. GRAPHIC ILLUSTRATION OF NOTATION VALUES

In dealing with whole numbers it is not necessary to consider the decimal point as we know that it is always on the extreme right, but in dealing with decimals or with numbers consisting of whole numbers and decimals we must watch the decimal point at all times in order to be sure of the value of the units represented.

To express twenty-five one-hundredths as a decimal, we would write 0.25 which signifies twenty one-hundredths and five one-hundredths or two-tenths and five one-hundredths. Similarly we would write twenty-five one-thousandths as 0.025 or two hundred and fifty one-thousandths would be 0.250. The cipher can be removed from 0.250, making 0.25 as in a decimal fraction ciphers on the right of the last integer do not change the value; but removing a cipher from between the integer or significant figure and the decimal point would increase the value of the fraction ten times. The reason for writing 0.25 is to signify without any question that there is no whole number to be used in connection with the decimal. It is not necessary but is simply a precaution against error.



FIGS. 2 AND 3. CHANGING COMMON FRACTIONS TO DECIMAL FRACTIONS
FIG. 4. EXAMPLE IN ADDITION OF DECIMALS

A decimal fraction may of course be written in the form of a common fraction by using the figure of the decimal as the numerator and the proper unit as the denominator; for instance, 0.375 is read 375 one thousandths and may be written $\frac{375}{1000}$. In numbers containing both whole numbers and decimal fractions, the whole number is read first and the fraction added, for instance 125.185 is read 125 and 185 thousandths.

Common fractions can be changed to decimals by dividing the numerator by the denominator. For example change ⅛, ¼ and ⅜ to decimal fractions. As will be seen by reference to Fig. 2, we place a decimal point on the right of the numerator and add ciphers then proceed as in short division and point off as many places in the quotient as there are ciphers. In the 3 examples given exact division can be performed without a remainder; but where the numerator is not exactly divisible 5 places of decimals is sufficient for practical purposes. As an example,

change 11/18 to a decimal fraction as shown in Fig. 3. It is evident that an indefinite number of operations could be carried out and each succeeding number in the quotient would be 1, so we place a + mark after the fifth decimal place or figure to indicate a remainder.

Addition of Decimals

TO add mixed numbers or decimal fractions place the numbers so that the decimal points come one under the other and proceed as in common addition, then place a decimal point in the sum under the decimal points in the numbers added.

Six car loads of coal and 3 wagon loads are delivered to a power plant. The first car contained 42.75 tons, the second 38.65 tons, the third 41.06 tons, the fourth 39.17 tons, the fifth 46.21 tons, the sixth 38.01 tons; the first wagon 4.01 tons, the second 3.125 tons the third 2.87 tons. What is the total weight in tons? See Fig. 4, for operation.

Where many numbers are to be added, the operation shown in Fig. 5 gives a rapid and simple method of checking the accuracy of the summing. Place the sum of each column under that of the one to the right

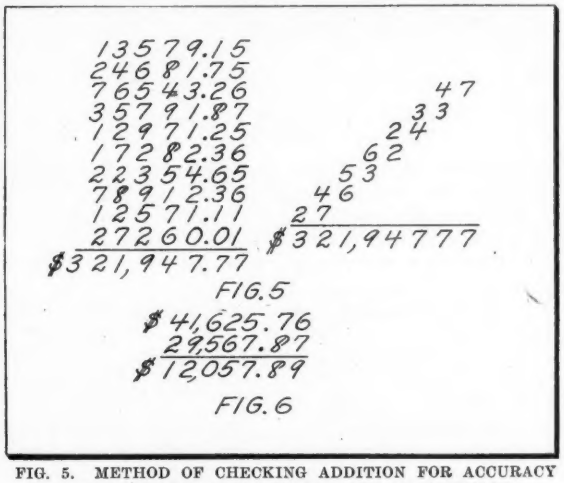


FIG. 5. METHOD OF CHECKING ADDITION FOR ACCURACY
FIG. 6. EXAMPLE IN SUBTRACTION OF DECIMALS

and one place to the left as shown. The various lines of figures are added as in common addition, then the sums of the columns are added. If the addition has been done correctly the results will correspond. By this method mistakes in the figures to carry are also practically eliminated.

Subtraction of Decimals

TO subtract decimals, place the subtrahend under the minuend so that the decimal point of the latter is directly under that of the former and proceed as in common subtraction placing the decimal point in the remainder under that of the subtrahend.

Some years ago a power plant was purchased for $29,567.87 and recently was sold for $41,625.76; what profit was made by the transaction? Referring to Fig. 6, the manner of solving this problem is shown to be by the subtraction of the original purchase price of the property from the selling price showing a gross profit of $12,057.89.

If during the interval between the purchase and sale of the property there had been expended $1750.00 for taxes, $768.73 for insurance and $1650.21 for improvements what would be the net profit of the transaction? We must first add together the amounts expended and subtract this sum from the gross profit of $12,057.89; as shown in Fig. 7, the net profit is $7888.95.

Multiplication of Decimals

MULTIPLICATION of decimals is performed the same as any example in multiplication and beginning with the right-hand figure in the product as many decimal places are pointed off as there are places in both the multiplicand and multiplier. There

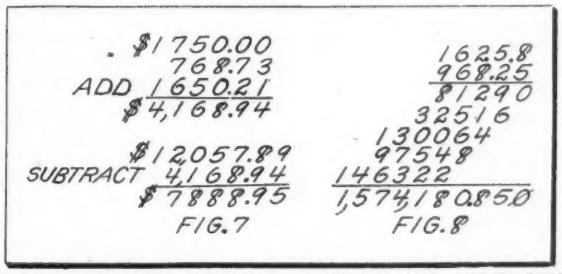


FIG. 7. EXAMPLE INVOLVING ADDITION AND SUBTRACTION
FIG. 8. EXAMPLE IN MULTIPLICATION OF MIXED NUMBERS

are 1625.8 barrels of tar in stock, each weighing 968.25 lb.; what is the total weight in pounds? By referring to the operation in Fig. 8, we find that the total weight of the tar, including that of the barrels, is 1,574,180.85 lb. There are 3 decimal places in the 2 numbers multiplied together, therefore, starting at the right hand in the product we count 3 places to the left and place the decimal point. The cipher can be eliminated, as we have already seen that removing ciphers at the right of a decimal fraction does not affect its value.

In the preceding example, mixed numbers were involved, but fractions can be multiplied in the same

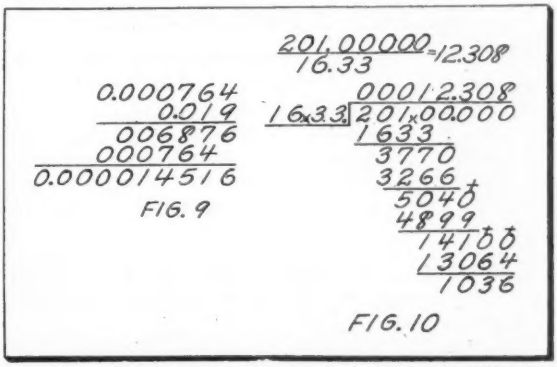


FIG. 9. EXAMPLE IN MULTIPLICATION OF DECIMALS
FIG. 10. DIVISION OF DECIMALS

manner as whole numbers; the only precaution necessary is to point off the proper number of places for the location of the decimal point. As an example; multiply 0.000764 by 0.019, as shown in Fig. 9. In the multiplier and multiplicand there are 9 decimal places; 4 more than there are figures in the product, therefore, we annexed 4 ciphers to the left to complete the decimal fraction and locate the decimal point properly.

Division of Decimals

ON 16.33 miles of street there are 201 arc lamps; what is the average number of lamps to the mile?

We are to divide 201 by 16.33, and to do this we put down the divisor 16.33 to the left of the dividend

201 and draw a line above the latter as shown in Fig. 10. When there are more decimal places in the divisor than there are in the dividend, it is easier in handling the computation to add as many ciphers as necessary to the dividend, and thus move the decimal point over to the right until the divisor becomes a whole number, moving the decimal point in the dividend the same number of places to the right. This amounts to multiplying both dividend and divisor by the same number and does not alter the value of the quotient.

In this case we add 2 ciphers to the dividend and move the decimal 2 places to the right in both divisor and dividend. We then proceed to put on ciphers above the line over the dividend until we come to a point where the divisor will be contained in the part of the dividend passed over, and then put down the stated number of times and proceed as in regular long division. We can add as many ciphers as may be desirable to the right of the decimal point in making this division to get the accuracy sought. The decimal point in the quotient will be directly above the transferred decimal point in the dividend, as seen in Fig. 10.

The rule for finding the decimal point in division is that the number of decimal places in the quotient equals the number of decimal places in the dividend minus the number of decimal places in the divisor. In the indicated division of Fig. 10, it will be seen that there are 5 ciphers added as decimal places to the original dividend, 201, and there are 2 decimal places in the divisor. The difference will be 3 decimal places which is pointed off in the quotient. The method of arranging the operation of division as indicated is simply a mechanical means of presenting the decimal point directly.

TEST OF A KEELER CROSS DRUM WATER TUBE BOILER

At Ft. Screven, Ga., United States Coast Artillery Corps

EVAPORATIVE tests on water tube boilers of small sizes are not very frequently made. Report of a test on a 75-hp. water tube boiler is of interest, owing to the small amount of data published. This test gives a good idea of the efficiencies that may be expected in daily service, as no unusual precautions were taken to secure unusual results. The boiler was new, the surfaces were clean, and the draft was no more than may be expected in any average plant.

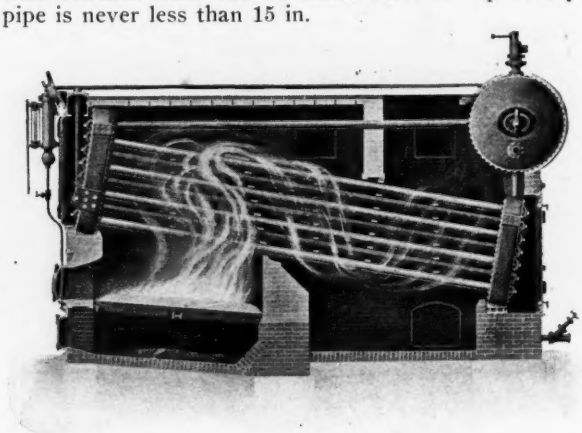
Although the rate of combustion is 13.4 lb. of coal per square foot of grate surface per hour, the boiler developed 95 hp. on a heating surface of 873 sq. ft.

The contract called for a rating of 75 hp. So this was 27 per cent more than the contract requirements.

In connection with this overload, it is interesting to note that the per cent of moisture in the steam is 8/10 of 1 per cent. This result is made possible by the circulation of water in the cross drum boiler.

In operation the water line is carried at the center of the drum. Feed water enters the lower part of the drum and is distributed by means of an internal perforated feed pipe. From the drum the water circulates downward to the rear header, forward through the inclined bank of tubes to the front header and backward to the drum through the horizontal circulating tubes. The steam and water traveling through these tubes must separate in passage, the steam rising and occupying the top half of the tubes and the water flowing in a solid body in the lower half. On entering the drum this water is deflected downward by a curved plate toward the vertical circulating tubes. The steam must pass around the ends of this plate before entering the steam space. A long, dry pipe is provided to prevent entrainment.

A cross drum boiler of 100 hp. has a liberating surface in circulating tubes and drum of 71.5 sq. ft. The distance from normal water level to top of dry pipe is never less than 15 in.



SECTION OF KEELER CROSS DRUM BOILER SHOWING PATH OF GASES

From the point where the steam begins to separate from the water it must travel the whole length of the circulating tubes and around the ends of the baffle plate before reaching the dry pipe.

Following is the report of the test:

Engineer	P. M. Anderson, Quartermaster's Department
Kind of fuel	Bituminous coal containing 13,710 B.t.u. per lb. of dry coal
Kind of furnace	Hand fired Ajax shaking grates
Grate surface	27 sq. ft.
Heating surface	873 sq. ft.
Duration of trial	8 hr.
Wt. of coal as fired	3029.5 lb.
Moisture in coal	4.7 per cent
Wt. of dry coal	2887 lb.
Total water	21940 lb.
Water evaporated, corrected for moisture	21,764 lb.
Factor evaporation	1.1992
Equivalent evaporation from and at 212 deg. F.	26,100 lb.
Dry coal per sq. ft. of grate per hour	13.4 lb.
Equivalent evaporation per sq. ft. of heating surface per hour	3.75 lb.
Average steam pressure	112.8 lb.
Temperature of feed water	59 deg. F.
Per cent of moisture in steam	0.8 per cent
Horsepower developed	95
Rated horsepower	75
Percentage of rated horsepower developed	127
Equivalent evaporation from and at 212 deg. F. per lb. of dry coal	9.04 lb.

AS A SUPPLEMENT to the decreasing coal supply of the country, the deposit found in the Bull Mountain Field in Montana is interesting. This contains in beds 14 in. or more in thickness, nearly 5,000,000,000 tons, of which, even with the present wasteful methods of mining, some 3,000,000,000 tons should be available for the market.

CURTIS STEAM TURBINES*

Suggestions for the Installation of Curtis Steam Generators, 5 to 15 kw. with Details of Mechanism and Instructions for Operation

IN Figs. 4. 5, and 6, the emergency valve mechanism of the Curtis turbine is shown assembled and mounted in a separate chest, the valve being a plain flap valve, A, suspended loosely on the resetting shaft C. The valve is normally held open by the latch B, which is keyed to the tripping shaft

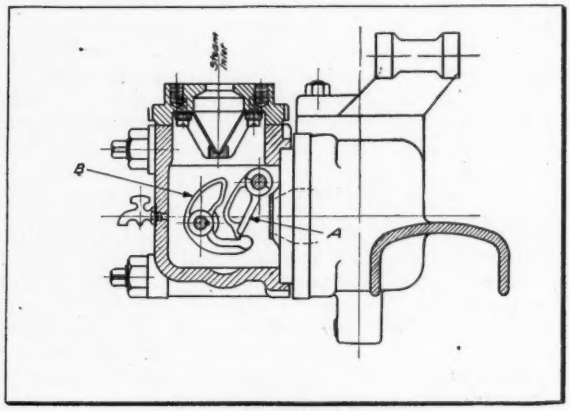


FIG. 4. EMERGENCY VALVE

D. This shaft passes through the plain bushing E, and the tripping lever F is keyed to the outside end.

This tripping lever, shaft and latch are normally held in the position shown by the square rod G, when engaged by the trigger H. Should the turbine reach

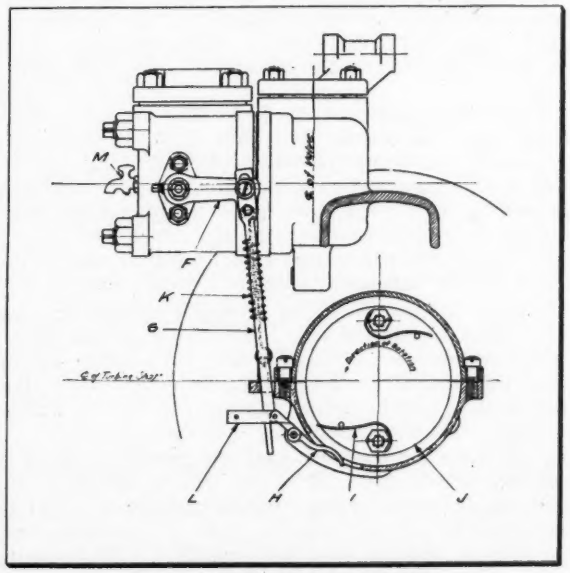


FIG. 6. EMERGENCY GOVERNOR

about 10 per cent overspeed, however, the free end of the clock spring emergency governor I, flies outward, tripping the trigger H and allowing the spring K to trip the mechanism. It is obvious that this mechanism may be tripped by hand by pulling up at lever L, thus releasing the trigger.

The entire mechanism, including the trigger, may be reset after closing the throttle and bleeding off the steam at M by lifting the handle N as far as possible. A lug on the collar which is fastened to the resetting shaft engages with a lug on the flap valve for this purpose. The resetting handle must always be returned to its stop, otherwise the emergency valve in closing will have to move this handle back against the friction of the stuffing box P.

No packing is used in the plain bushing E and any small amount of steam which may leak through is caught in the small chamber R and returned together with the drip from the valve spindle and the tail rod through the brass piping on the right-hand side of the steam chest to the drain.

When shipped from the factory the emergency governor springs are adjusted and tested to trip at

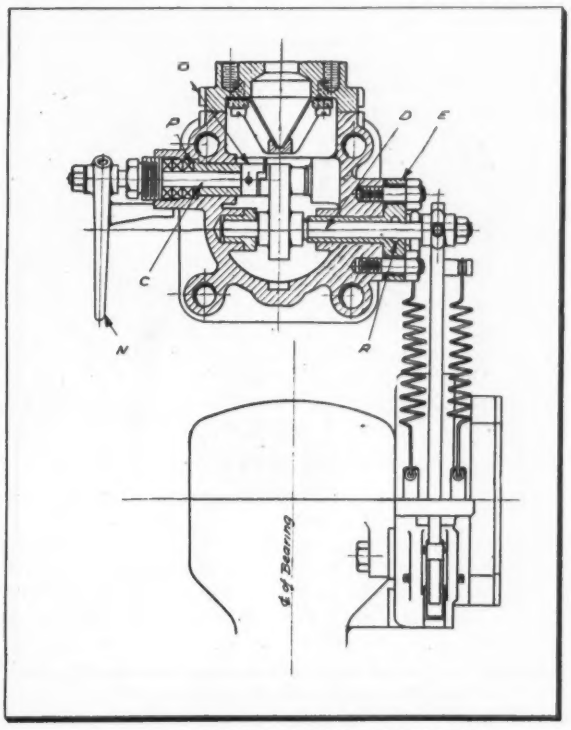


FIG. 5. EMERGENCY GOVERNOR MECHANISM

about 10 per cent, above normal speed rating. When replacing these springs, care must be taken to obtain proper tension, which will generally occur when the scratch mark on the spring stud is opposite the scratch mark on the emergency disk. The turbine should be occasionally tripped by pressing outward on the governor lever but operating at no load to insure that the emergency governor mechanism is in operating condition. Increase of speed can be determined by noting the increase in the line voltage.

Packing

ARRANGEMENT of the packing is shown in Fig. 7. The packing in the shaft where it passes through the wheel casing of condensing machines consists of 3 rings of carbon in the high-pressure end, and 2 on the low-pressure or exhaust end, which run on the

*Continued from page 837 Aug. 15 issue.

shaft without lubrication and form a steam tight joint. Except in special cases 2 rings are used on the high, and none on the low-pressure end of noncondensing turbines.

Each ring is made of 3 segments to insure a better fit on the shaft, and to allow wear to be automatically taken up. Each ring is carried in a circular cell of close clearance. The segments are held together and against the shaft by the spring-backed holders. Each carbon segment is provided with a keyway with which the key riveted to the brass holder engages. The outer lug on the brass holder engages the lug which is tapped rigidly in the cell, thus preventing the unit from revolving with the shaft.

Outer, or face rings, on both the high- and the low-pressure ends have overlapping joints to prevent steam leaking radially through them. The inner or covering rings have plain butt joints.

On assembling the packing, care should be taken to see that the lap joint rings are assembled in the outer cells of the high- and low-pressure ends only.

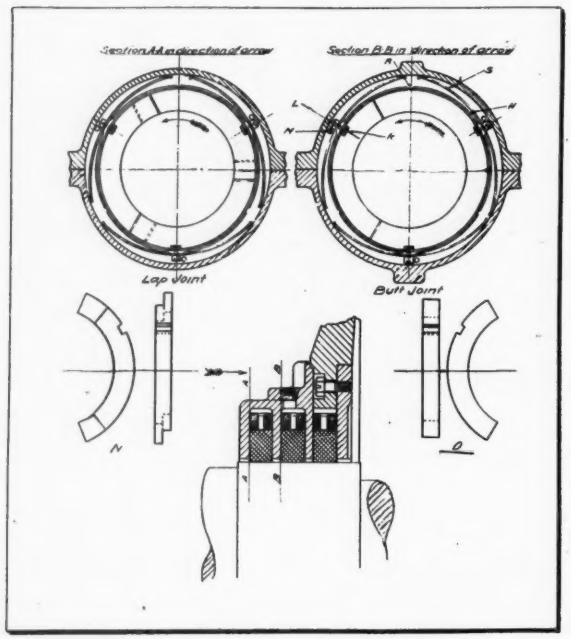


FIG. 7. ARRANGEMENT OF PACKING

Segments which are cracked or chipped should not be used. Before putting in new packing it should be made certain that the joints fit each other accurately and that the 3 segments of a ring are of the same thickness. These segments are not interchangeable. If one is damaged a complete new ring should be installed. Great care should be taken in assembling the packing to see that all lugs and keys are in their proper places and that the different segments which constitute a ring, and which are plainly marked, are not mixed with the segments of other rings.

All condensing machines are provided with a steam seal. Live steam is supplied to both the high-pressure and the exhaust-head packings through a reducing valve and pop valve. The reducing valve should be set at about 4 lb. gage pressure, which in case of air leakage may be increased to 10 lb. The pop valve should be set at 12 lb. to prevent high pressure on the packing in case of stickiness of the reducing valve. The drains from one packing casing are to be run to the atmospheric line and under no condition is back pressure to be allowed to accumulate in them. When operating a condensing turbine as a noncondensing, no steam should be delivered to the steam seal.

Back Pressure Tripping Device

TO meet special conditions, an additional tripping device is added to trip the standard emergency governor mechanism when the pressure in the exhaust head rises above its predetermined amount. This is shown in Fig. 8. The mechanism consists of a diaphragm actuated by steam admitted from the exhaust head through a pop valve. Steam acting against this diaphragm moves it downward and acts on a lever, one end of which rests below the emergency trigger. An additional pop valve is furnished as a tell-tale.

Starting the Set

BEFORE starting the set for the first time, see that all nuts and screws are tight and that the moving parts are free. Fill the oil well of the main bearing and commutator end bearing. Fill the oil cup for lubricating the thrust ball well with cylinder oil. Lubricate the ball bearing and governor lever and glands referred to under lubrication. Try the armature by hand to make sure that it runs free in the bearings and that the intermediates and the nozzles are not striking.

Start the machine slowly under steam and see that the oil rings are working and distributing the oil properly. As the speed increases and approaches normal, push lightly on the governor lever from time to time in order to make sure that no parts have become jammed during shipment. When the machine has reached normal speed the governor should act and move inward, maintaining the speed. The emergency may next be tripped to test the operation of the emergency device.

Emergency governor should work at approximately 10 per cent over speed. If it fails to do so, it should be reset by loosening the nut which holds the emergency spring and twisting the stud slightly so that the spring bears with more pressure against the stop in case the emergency trips at too low a speed, and with less pressure if it trips at too high a speed. The nut should be tightened again with great care.

This procedure with the governor applies only to the first starting of the set. Under ordinary conditions steam may be turned on and the set brought up to speed in about 15 seconds. Test the emergency valve from time to time by holding the governor out of action as described under emergency governor.

When the set has been brought up to speed and is running satisfactorily, close the field switch and see that the armature voltage builds up properly. If it does not do so, trace out the field connections, test the polarity and examine the brushes. When trouble in building up is encountered, it will, as a rule, be found in loosened or otherwise improper connections.

Care of Set

COMMUTATOR brushes and brush holders must be kept clean and free from dust. Wipe the commutator from time to time with a cloth lightly coated with vaseline. If vaseline can not be obtained, use clean oil, but lubricant of any kind should be used very sparingly. The armature connections and field coils should be blown out frequently with compressed air.

If the machine has a tendency to spark there is something wrong which must be remedied at once. If severe sparking is allowed to continue any length of time, serious injury to the commutator is inevitable. A piece of fine sandpaper applied to the commutator running at full speed, preferably with brushes raised, will usually remedy the fault. If the commutator is still rough or eccentric it will be necessary to turn it.

After turning, and before putting on load the edges of the bars should be slightly scraped and burnished to remove burrs and the surfaces of the commutator should be smoothed with fine sandpaper to remove the tool marks. After the commutator has been sandpapered, wipe it to remove any grit which may have adhered to it or to the brushes and would cause cutting. Emery cloth must never be used on a commutator or brush. Great care is to be taken at all times not to injure the insulation on and at the sides of the shrink ring.

Carbon brushes vary greatly in quality and consequently in action. Fit the brushes carefully to the

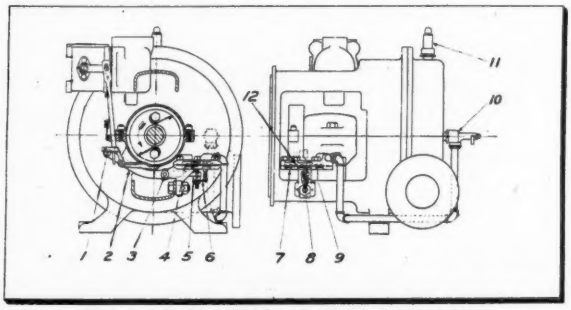


FIG. 8. BACK PRESSURE TRIPPING DEVICE

commutator by passing beneath them No. 0 sandpaper held closely to the surface of the commutator. Move the paper back and forth, being careful to see that it does not leave the surface of the commutator while in motion, since in such case the edges of the brushes may become slightly rounded and the result may be unsatisfactory. An equal tension of 2 lb. per sq. in. is to be kept on the brushes by tightening the springs in the brush-holders as the brushes wear down. The brushes should be inspected occasionally to see that the copper plating does not come too close to the surface of the commutator or glowing will ensue. The pigtails are to be examined from time to time to see that they do not fray off and that a good contact is always maintained.

SOLVING THE SMOKE PROBLEM*

By Birger F. Burman

WITHOUT doubt the simplest device which absolutely and most clearly tells the real truth on the smoke abatement problem is our old kerosene lamp. There the fuel is fed through the wick and regulated by the screw; there is the chimney—the glass—and finally the holes for air supply regulated by valves. We all remember that when lighting the lamp we at first "screwed it low." Why? Not only to prevent the glass from breaking, but also gradually to heat it to prevent soot depositing on it. After the glass was hot we "screwed up the wick," but only to a certain point, because there was only one such point that gave us the best light. If higher, the lamp smoked; if lower, the light was poor; in both cases incomplete or poor combustion took place.

That point is the balance point representing complete and economical combustion for the lamp. It is governed by the screw, controlling the fuel supply and the size of chimney and the air valves. In other words there is a perfect balance between fuel and air supply. Can we find any better illustration?

Possible Losses with Absence of Smoke

IN industrial furnaces, as a rule, the conditions are not so favorable, and ordinarily it is impossible to regulate the conditions without special continued precautions to keep up the balance point. Some stoker man perhaps will tell you that his device will do it, but be cautious; sometimes he is fairly successful, but often his machine is very troublesome.

We are all the time talking about smoke and how to prevent it. If that is the only object of our fight, let us do like those who lead the exhaust steam through the chimney or like those who pull an enormous amount of air through the furnace. In both cases there is no smoke or at least it is only light in color, to the entire satisfaction of all concerned.

Let us make an analysis of the gases that are so satisfactory and perhaps the owner at least will not feel so easy. For years his engineer has not been able to come up to more than approximately 6 per cent carbon dioxide at a flue gas temperature of about 600 deg. F. Thus he has been running his boiler furnaces with about 200 per cent excess air and lost about 18 per cent of his coal that could and should have been saved. But his poor stokers too have been carrying ash with 30 per cent carbon, which adds another 6 to 8 per cent to the loss, making total preventable loss approximately 25 per cent.

Automatic Flue Gas Analyses

WE are now stepping in on the field of automatic flue gas analyses as the only absolutely sure and reliable way of dealing with the smoke problem. With a CO_2 recorder as a guide we are able to come as close as possible to the ideal conditions of the kerosene lamp whether the furnace is equipped with a stoker or not. Like a pilot with his hands on the wheel and his eyes on the compass, so the man in charge of the furnace will hold his hands, figuratively speaking, on the damper and fuel feed and his eyes on the CO_2 recorder.

To obtain smokeless furnaces the first and most important point is to convince the manager of the furnaces. As long as he does not see the money value of it, it will be a more or less unpleasant fight. Every thoughtful engineer knows the value of a good CO_2 recorder and realizes its necessity, but he cannot get the manager to see it. This man will rather go on allowing combustion that robs his company of tens of thousands of dollars a year than to make any changes whatever. Again there are efficiency engineers who seldom go beyond actual time studies, etc. They take contracts to overhaul whole plants, but never touch such an important point as economical combustion.

The value of a CO_2 recorder in any plant does not consist merely in showing the kind of combustion there may be. It acts also as the visible representative of the manager himself. After its installation give an employee exclusive charge of it and inaugurate a bonus system for paying firemen. Then that disagreeable smoke problem will be solved.

*Based on a discussion of smoke abatement before the Engineers Society of Western Pennsylvania.

MENSURATION

Figuring the Area of Quadrilaterals and Triangles Arithmetically and by Means of the Slide Rule

FOR figuring the area of surfaces of common shape, there are several rules which for convenience may be written as formulas and which can be worked to advantage on the slide rule. Take the case of the square, every one knows that the area is found by multiplying the 2 sides together or by squaring one side. In Formula 1 of Fig. 1 this is indicated by letting S be the side of the square and then the area is equal to S squared.

It so happens that the diagonal d of the square has its square equal to the sum of the squares of the 2 sides so that d^2 equals S^2 plus S^2 or 2 S^2. Turning this around it is evident that S^2 equals one half

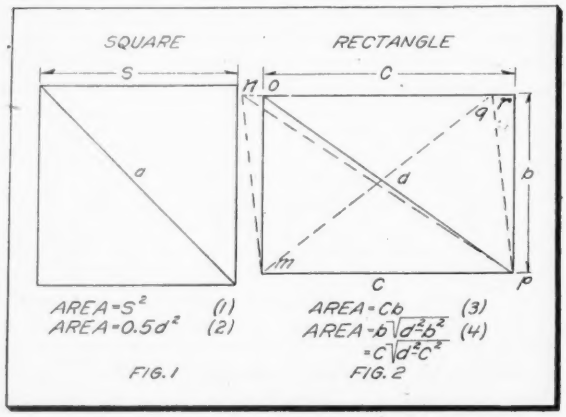


FIG. 1. DIMENSIONS AND FORMULAS USED IN FINDING THE SURFACE OF A SQUARE

FIG. 2. DIMENSIONS AND FORMULAS USED IN FINDING THE AREA OF A RECTANGLE

d^2 or 0.5 d^2 and as seen before this is equal to the area so that we get Formula 2, the area equals 0.5 d^2.

If the side S of the square is 15 in. the area will be 15 times 15 or 225 sq. in. If in another square the diagonal d is 20 in. the area of the square will be 20 times 20 times 0.5 or 200 sq. in. With these figures the problem is very simple, but suppose that the diagonal of the square happens to be 297 in. the computation becomes more tiresome. In this case we go to the slide rule and turning the runner at 297 on the D scale we read on the A scale directly above 885, which by inspection we can see is 88,500, since 300 times 300 would be 90,000. This is the square of 297, and to multiply it by 0.5 we bring one on the B scale to the runner and carry the runner to 5 on the B scale and under the runner on the A scale we find 443, or 44,300 sq. in. as the area of the square. If this process seems complicated to comprehend try the second example. By placing the runner at 20 on the D scale and directly above on the A scale will be found 400; bring 1 on C to the runner and carry the runner to 5 on B and under the runner on the A scale will be found 200, the answer.

Area of Rectangle and Parallelogram

WE are all familiar with the fact that the area of a rectangle is equal to the product of the 2 sides or in Fig. 2 c x b as expressed in Formula 3. By the same rule as in the square, the diagonal d squared is equal to the sum of the squares of b and c. $d^2 = b^2 + c^2$. Then to get the value of c^2 we would subtract b^2 from d^2 and to get the value of c extract the square root of this, or we should have c equals the square root of d^2 minus b^2 and putting this in place of c in the Formula 3 we would have the area equals b into the square root of d^2 minus b^2; or by a similar reasoning if we knew c and d, we would have the area equals c into the square root of d^2 minus c^2.

As a test problem if c equals 18 ft. and b equals 9 ft. the area will be $18 \times 9 = 162$ sq. ft. Again if in a

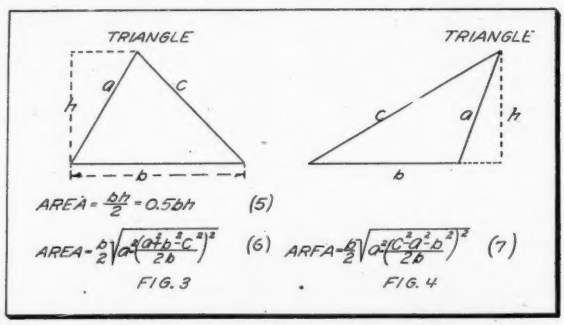


FIG. 3. ARITHMETICAL OPERATIONS FOR FINDING THE AREA OF A TRIANGLE

FIG. 4. OBTUSE-ANGLED TRIANGLE AND FORMULA FOR AREA

rectangle the side b is 11 in. and the diagonal is 36 in., we shall square the diagonal, subtract the square of the given side, extract the square root of the remainder and multiply this square root by the given side, or expressed by the formula

$$11 \times \sqrt{36^2 - 11^2} = \text{the area},$$

which works out to 376.2 sq. in.

To use the slide rule on this, place the runner at 36 on the D scale and read 1296 on the A scale; this is the square of 36; place the runner at 11 on the D scale and under the runner read 121 on the A scale; this is the square of 11. Subtracting gives 1175, of which we have to extract the square root. Point off the number into periods of 2 figures each and if the number of periods is a whole number, work with the right hand A scale in finding the square root. If the number of 2-figure periods is fractional work with the left hand A scale In this case there are 2 places of 2 figures each so we work with the right hand A scale and placing the runner over 1175 we read under the runner on the D scale 342, which must be 34.2 as there are 2 periods in the whole number of which we are extracting the square root. Now bring left hand index of the C scale 1 to the runner and bring the runner to 11 on the C scale and under it on the D scale will be found 376 or 376 sq. in. the area of the rectangle.

In the case of a parallelogram, mnqp Fig. 2, the area is equal to the base c times the altitude b. The altitude b is not the same as the side pq but it is evident by inspection that the triangle m o n has the same area as the triangle p r q, hence when we cut off the triangle p r q from rectangle we have the same lines as the triangle m n o at the other end and it has an equal area, making the area of the parallelogram the same as that of the rectangle which has the same height. The same rule and method applies for the parallelogram as for the rectangle in regard to

the product of base times altitude, but it is not possible to use the rule which brings in the diagonal of the rectangle in the case of the parallelogram, as the 2 diagonals are not of the same length.

Area of a Triangle

IF the rectangle in Fig. 2 is inspected, it will be seen that the diagonal divides it into 2 triangles each equal to half the rectangle, hence the area of the triangle o r p will be equal to half the base c times the altitude b.

In like manner by inspection of the parallelogram m n q p it will be seen that either the diagonal n p or the diagonal mq divides the parallelogram into equal triangles. We have already seen that the area of the parallelogram is equal to the base times the altitude, therefore we would note that the area of any one of the triangles into which the parallelogram is divided by its diagonals is equal to half the base times the altitude which is expressed by Formula 5 of Fig. 3.

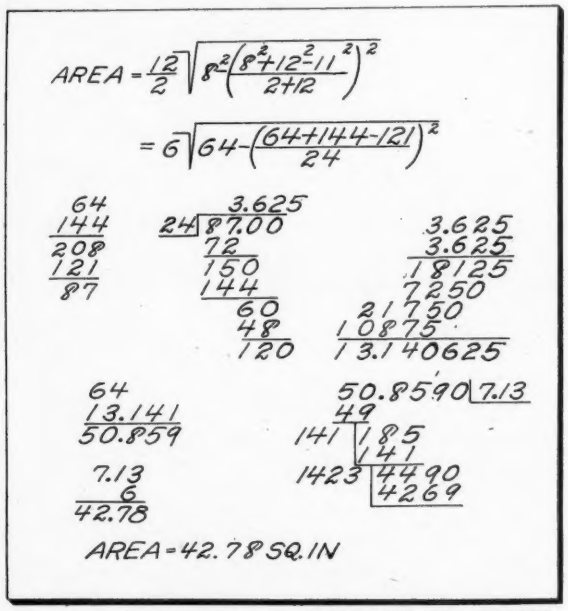


FIG. 5. AN ILLUSTRATION OF DIMENSIONS FOR SCALENE TRIANGLE

In the case where the 3 sides of a triangle are given instead of the base and altitude, 2 different forms of rule are necessary. In the form shown in Fig. 3, the acute-angled triangle, the Formula 6 of Fig. 3 applies. The obtuse-angled triangle of Fig. 4 the Formula 7 of Fig. 4 applies. The method of making the calculation is similar in the 2 cases and only one will be worked out in detail.

Take the case of Fig. 3. If a equals 8 in., b equals 12 in. and c equals 11 in., what is the area of the triangle in square inches? The arithmetical operations are seen performed in Fig. 5.

In using the slide rule for this work it does not pay to perform operations which can be quickly and easily done mentally, such as the dividing of 12 by 2, or the squaring of 8, 12 or 11. The first operation in which the slide rule can help is dividing 87 by 24. To do this place 24 on the C scale over 87 on the D scale and under 1 on C read 3.625 on D. This is to be squared so we take the runner to this point and under it on the A scale we read 13.15.

This is subtracted arithmetically from 64 giving us 50.85 of which we are to extract the square root. As this left hand 2-place period is larger than 10 we know that we are to use the right hand A scale in extracting the square root, and placing the runner at 5085 on the right hand scale we find under the runner on the D scale 713 which from inspection we can see to be 7.13. Slide the right hand index on the C scale to the runner and carry the runner to 6 on the C scale and under the runner will be found 4278 on the D scale or 42.78 sq. in. the answer.

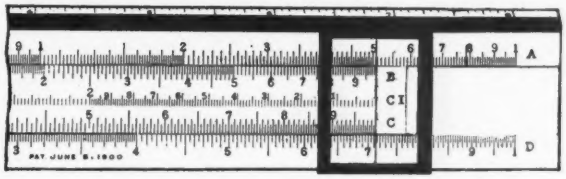


FIG. 6. FINAL SLIDE RULE SETTING IN COMPUTING AREA OF TRIANGLE FROM SIDES

SAVING WITH MAGAZINES

By C. L. Herrick

JUST as important as, if not more than, good equipment in the engine room is the training in how properly to repair and operate that equipment. Even in the largest plants a man can hardly get a broad enough exchange of ideas among his few coworkers, without reference to text books or periodicals on engineering subjects. For this reason the best engineers and their assistants keep on hand standard reference books on electricity and mechanics, as well as subscribe for good magazines dealing with the particular phase of the work in which they are most actively engaged.

A certain chief engineer, who has risen to the top of his profession through earnest study, each year before Christmas subscribes for 5 copies of Practical Engineer, one copy for himself and the remaining as Christmas presents for the 4 men who have last entered his employ. He finds the increased interest of his men in their work is ample return on the investment. After getting an initial subscription of this magazine the men very rarely fail to renew it at their own expense when the year is up. By having the same magazine established among all the workers there is a greater opportunity and tendency for general discussion of the problems and question presented in this publication each month.

In the center of this particular engine room, against a pillar, is built a small bookcase in which are kept a set of ready reference books on machine repair and standard wiring diagrams, explanations and rules, together with a copy of each issue of the above-mentioned magazine. It goes without saying that these references are well-thumbed and are probably responsible for a great deal of the efficiency and economy in this plant.

ENLARGEMENT HAS recently taken place of Moloney Electric Company of St. Louis, which manufactures high-pressure transformers for long distance electric transmission plants. The capital stock has been increased from $40,000 to $700,000 and the plant and selling facilities will be greatly increased.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

GAS ENGINE IGNITION

Care of Batteries; Correct Connection in Series and Series-Multiple; Use of the Built-In Magnets

By H. R. Van Deventer

GAS engine users, having battery ignition outfits, should test the batteries at least once a week by loosening the wire from the engine igniter, and tapping it on the post where the wire from the battery or coil connects to the engine frame. This tapping should show a fat, bright spark; if not, proceed as follows:

See that all connections are clean and tight. Examine switch, if one is used, and see that the blades are free from grease and dirt, and make a good connection.

Remember the wire must be clean and bright. The insulation must be off where it is attached to a post, There must be no loose joints.

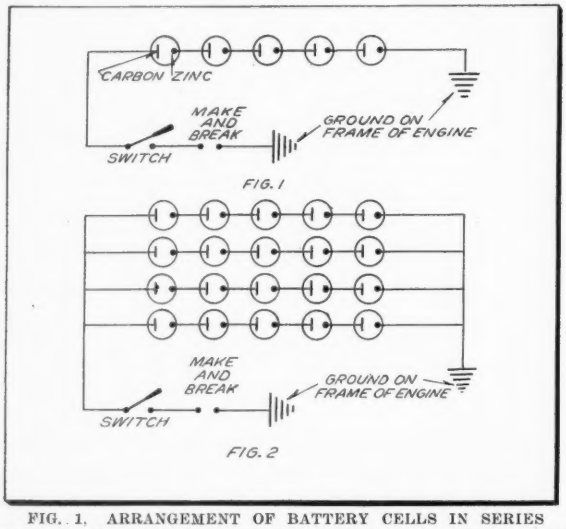


FIG. 1. ARRANGEMENT OF BATTERY CELLS IN SERIES
FIG. 2. SERIES-MULTIPLE ARRANGEMENT OF BATTERY FOR LONG LIFE

Examine the spark coil and see that the terminals or connections where the wire joins on, do not touch each other. If the coil is wet with oil or water it will not work.

Wet spark coils can sometimes be repaired by putting them in an oven and baking at a heat not exceeding boiling water, until thoroughly dried out. Be careful not to have heat great enough to melt the compound in which the coil is immersed, or it will split the wooden heads.

Series Connections

REMEMBER the zinc of one battery cell must connect to the carbon of the next. The zinc terminal is always the post on the outside can or shell on a dry battery and the carbon terminal the one on the black rod sticking up in the middle. If batteries are connected up any other way, they will not work properly.

To test the batteries to see whether they are strong enough, take a very fine copper wire or a pin and hold it firmly against the post on the zinc. Let the pin point just touch the black part of the carbon but not the brass post. If a small puff of smoke is seen and a tiny spark, or the pin seems warm, it is an indication that the battery is all right. Hold the pin on the carbon for only a few seconds. If no sign of spark can be seen, batteries are probably exhausted, and a new set should be procured.

It is always better to have an ammeter or measuring instrument for testing batteries, and they should be tested every week. Batteries showing less than 6 to 8 amperes will not give good service.

Read your engine instructions carefully and don't try to use more batteries in series than the makers recommend.

Series Multiple

GAS engine users who want the best battery ignition, use what is known as the "series multiple" arrangement in which 4 groups of cells, 5 in a group are used. When 20 cells are so arranged their life is 8 times that of 5 cells. But even with this arrangement the battery will give trouble sometimes, as regardless of the number or kind of batteries used, or their arrangement, batteries become exhausted with age, even if not in use.

It will be well to remember that a battery will not give a uniform spark all day. In the morning, when the engine is first started, the spark may be entirely satisfactory. In the afternoon, after the engine has run several hours, and the batteries begin to weaken, the spark weakens, and the engine begins to miss. This means that the batteries are getting weaker. Do not attempt to remedy this trouble by adjusting the engine igniter, but give the batteries the attention they demand.

Rough treatment tends to shorten the life of batteries. Handle them gently. Do not remove the pasteboard covers.

Excessive heat shortens the life of batteries; cold makes them inoperative until thawed out.

Don't keep batteries in a hot place. Don't lay them on sides, but always stand on end. Don't buy so many that you will have to keep them on hand for months. Get new fresh cells as needed.

Magnetos

SLOW-SPEED engine timed built-in magnetos are an up-to-date device for the gas engine. They are independent of heat and cold. As the magneto forms part of the engine, it will run anywhere and give a good spark as long as the engine runs. The "built-in"

type of magneto should always be specified on engines to be used for portable and power work, as they are entirely independent of the many conditions which affect battery ignition. Magneto ignition is always uniform, as it depends upon the engine power and not chemicals, for its generation. The best magnetos have means for visibly timing them, so that any one can readily determine whether the spark is properly in time.

THE GAS PRODUCER AND THE INTERNAL COMBUSTION ENGINE*

By Robert H. Fernald

INVESTIGATIONS into the possibility of generating producer gas for power purposes in a commercial way from the various mineral fuels of the country has been carried on for some time by the United States Government. These investigations have been associated with steaming, briquetting, coking, and other tests, all of which supplemented an examination into the nature, extent, and distribution of the fuels used. The tests have been made with carefully selected representative samples and carload lots of coal, lignite, etc., procured especially for the purpose by experienced collectors.

In New England, for example, marked economies can be gained by a general use of the gas producer, and moreover these economies would be sufficient to overcome the handicap placed on industries there by the transportation charges on coal. The development of power in the New England States through the efficient method suggested by these investigations would mean a yearly saving of many millions of dollars.

Many states of the West that have no good coal are also greatly benefited by the investigations, which have shown the adaptability of the gas producer for the utilization of low-grade coal, lignite, peat, etc. As mined, these fuels can not be used in boiler furnaces and will not bear long transportation, but the gas producer makes them of potential value. Thus the gas producer is an agency of conservation. It helps to keep the low-grade coals from being permanently lost by being left in the mines in such condition as to make their future recovery impossible.

In states in which deposits of low-grade coal, lignite, and peat are found, the present cost of power, as developed in steam plants with coal that has been shipped a considerable distance, can be materially reduced by placing producer plants at the mines or bogs, so as to utilize these low-grade fuels without cost of shipment by generating electric current which can be easily transmitted to desired points within a wide radius.

The tests in the gas producer have shown that many fuels of so low grade as to be practically valueless for steaming purposes, such as slack coal, bone coal, and lignite, may be economically converted into producer gas and may thus generate sufficient power to render them of high commercial value.

It is estimated that on an average each coal tested in the producer-gas plant developed 2½ times the power that it would develop in the ordinary steam-boiler plant.

It was found that the low-grade lignite of North Dakota developed as much power when converted into producer gas as did the best West Virginia bituminous coals burned under the steam boiler.

Investigations into the waste of coal in mining have shown that it probably aggregates 250,000,000 to 300,000,000 tons yearly, of which at least one-half might be saved. It has been demonstrated that the low-grade coals, high in sulphur and ash, now left underground, can be used economically in the gas producer for the ultimate production of power, heat, and light, and should, therefore, be mined at the same time as the high-grade coal.

In line with this conservation of fuel resources it is interesting to note that one estimate states that the United States Steel Corporaion alone, through installations of blast-furnace gas engines to displace the old equipment saves approximately 1,000,000 tons of coal per annum.

Investigations also show that the general use of gas producers for the development of power means the elimination practically of the smoke nuisance. This result is especially important in cities that are compelled to use bituminous coals.

The great saving in fuel obtained through the gas producer has led to the installation within the last decade of several hundred of these power plants throughout the United States. These producer plants are practically smokeless during operation.

As a smoke preventer, the gas producer is one of the most efficient devices on the market, and furthermore, it reduces the fuel consumption not 10 or 15 per cent, as claimed for the ordinary smoke preventing device offered for use in steam plants, but 50 to 60 per cent.

The establishment of producer-gas plants at the mines and the distribution of electric energy or gas over large areas will also tend to eliminate smoke. When a large percentage of the small, isolated, power and heating plants and all steam locomotives have been removed from the larger cities, the atmosphere of these cities will be much clearer and heavy financial losses directly traceable to smoke will be eliminated.

*Introduction to Technical Paper No. 9 of the United States Bureau of Mines. Copies of the paper may be obtained from the Bureau, Washington, D. C.

GAS ENGINE TROUBLES

IF the engine fires irregularly it may be due to any of the following causes: Insulation broken on wires, causing a short circuit in the electric current. The contact at the timer may be poor, or the terminals on the coil may be loose or corroded. The spark plug may be cracked, or the points not properly adjusted. They should be about 3/32 in apart. In case of a weak battery they may be closed a trifle. The fuel supply may not be regulated correctly; it might be so rich it will not ignite, or so weak it cannot be ignited. In either case the engine would run irregularly. The spark coil may be poorly adjusted, or the platinum points pitted and stick.

Sometimes an engine will fire regularly but have no power. In this case it may be due to poor compression, which is due to worn or broken rings, broken or warped valves, leaky gaskets, scored or worn cylinder walls and weak valve springs. The fuel mixture may be weak or lubrication poor. Muffler may be stopped with a sooty deposit until the back pressure will destroy the power. The exhaust valve may be lifted only part way, not allowing the burned charge to be expelled from the cylinder.

A hissing sound can be caused by a broken spark plug allowing the compression to be forced through the fracture, or by the compression blowing past the

rings. A cracked exhaust pipe, or an open compression cock, will emit a hissing sound, as will a blown gasket between the exhaust pipe and the muffler.

In case the engine refuses to start, something may be broken, but, if such is not the case, the trouble will likely be found in some of the following: Cylinders dry for the want of oil; foul or broken spark plug; poor compression as described in irregular firing; the batteries may be exhausted or some of the connections broken; the switch may be broken or not turned on. Water in cylinder caused by a leak in the water jacket will prevent the engine from starting. The inlet valve if not mechanically operated will many times stick and prevent the engine taking a charge of fuel. An excessive amount of lubrication in the cylinder makes starting difficult, especially in cold weather.

If engine runs well and stops suddenly it may be caused by the spark plug being broken or blown out, a broken wire, or the batteries run down. A loose terminal may be the cause, tremble spring on spark coil stuck, trouble at contact points of timing device, gears jammed or broken, valves stuck or broken.

In case the engine runs but seems to have no power, look for the following: Over-rich mixture, caused by too much gas and not enough air; weak mixture, caused by too much air and not enough gasoline; loose or slipping fly-wheel, insufficient lubrication, valves in bad condition, worn or broken rings, weak batteries.

If the engine has been running well and gradually slows up, missing explosions, look for trouble in the fuel supply, or fouled spark plugs, insufficient lubrication, weak batteries, wiring defective, being nearly broken and hanging by a thread, or loss of compression.

Explosions in the muffer are due to any of the following: Exhaust valve stuck, weak mixture failing to burn in the cylinder and burning in the muffler, weak spark not firing the charge until the working stroke is nearly finished. In this case it will not burn while passing to the muffler.

The water getting too hot, causing overheating, is generally caused by some of the following: Clogged pipes, incorrect timing of the valve, fan not working, pump broken or disconnected, oil in the water, muffler stopped up and a very late spark. In case there are explosions in the mixing valve, look to the intake valve or its spring. The valve may be broken or leaking, or the spring may be weak, not seating the valve properly, or the mixture may be weak, late spark, or the valves incorrectly timed.

When the engine begins to knock it should be stopped at once and some of the following examined: Fly-wheel may be loose on the shaft, or the cylinder may be loose, rings may be broken or badly worn, bearings may be loose and need tightening, carbon deposit on the cylinder head, spark occurring too early, over-rich mixture, loose crosshead bearing, and defective lubrication—this will cause knocking when the piston is about to seize.—"Gas Power."

SOME YEARS ago a letter was received by the Westinghouse Machine Co., which said that the writer has been using one of its standard vertical engines with eminent satisfaction. For 8 yr. it had been in continuous service night and day, handling its load without a hint of trouble, but that "upon shutting it down the other evening it went all to pieces." The letter was passed to George Westinghouse who handed it back with the remark: "Ask the blamed fool what he shut it down for."

SPRAY COOLING PONDS

Details of Spray Nozzles; Water Pressure Recommended; Size of Ponds Required

A SPRAY COOLING pond affords an efficient and economical means for obtaining an artificial water supply required by industries located away from streams or natural ponds, for condensing steam, or use in water-jacketed furnaces, oil engines, air compressors, ice machinery or other apparatus. By its use a great saving of water is effected, as the hot water from the condenser or water jackets is cooled by spraying and falls back into the pond cold enough to permit of its being used over again.

Recent Developments

AS in all other lines of industry, great improvements have been made in the essential features of spray-cooling systems, particularly in the nozzles and spray arrangements. These improvements also affect the area and initial cost of ponds, which have been so reduced as to make them a practical installation for plants requiring an artificial water-cooling system. So many spray-cooling plants are now in successful operation throughout the country that they have long since passed the experimental stage.

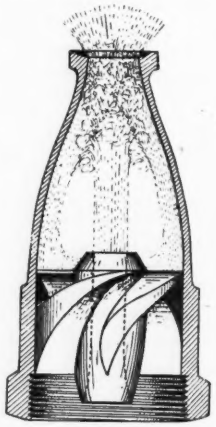


FIG. 1. CROSS-SECTIONAL VIEW OF SPRAY NOZZLE

FIG. 2. SECTION THROUGH SPRAYS

The spray nozzle is the most important feature in a cooling system. Its office is to break up a large quantity of water into a fine uniform spray at low operating pressure, without liability to clog up or otherwise get out of order. These requirements have been successfully met by the new nozzles designed by Spray Nozzle Company, of Boston. As will be noted in the sectional illustration, they are provided with removable turbine centers having large passageways. The centers are held stationary in the nozzle shell so that there are no movable parts to wear out; and the water in passing through is given a rapid rotating motion. It is driven forth by a central driving jet, which impinges on the rotating water at the orifice, causing it to be ejected in a fine, dense, uniform spray. The central driving jet performs another function equally as important in a cooling nozzle. It fills in the hollow, conical form which the spray would otherwise take. Figure 2 shows the character of spray produced by these nozzles.

Power Requirements

FOR spray systems used in connection with condensers carrying 26 in. vacuum, the power necessary to operate the sprays should not exceed 1 per cent of the power generated by the engine. For spray systems used in connection with turbines requiring 28 in. vacuum, 2 per cent of the power generated by the turbines will be ample allowance. The usual operating pressure per square inch varies from 6 to 12 lb. according to the size of the nozzle.

For spray-cooling ponds nozzles of the following sizes and capacities are recommended. By increasing or decreasing the diameter of the orifices the capacities can be changed 30 per cent or more for any particular nozzle, but the result will not be so satisfactory as by adopting these standards. The height of spray will approximate 1¼ ft. for each lb. operating water pressure:

Spray Nozzle	Diameter of Orifice	Diameter of Supply Pipe	Capacity in Gallons per Minute		
			At 6 lbs. Pressure Per Sq. Inch	At 10 lbs. Pressure Per Sq. Inch	At 15 Lbs. Pressure Per Sq. Inch
No. 10	½″	1½″	15	21	23
11	¾″	2 ″	33	44	50
12	1 ″	2½″	70	93	102
14	1½″	3½″	—	190	210

Spray Arrangement

NEXT in importance to the design of the nozzle is the arrangement of the sprays. As a result of careful tests the Eneas system has been adopted for recent installations.

In this system the nozzles are arranged in groups and are so inclined toward the opposing nozzles that, when the sprays are operating, they are made to impinge against each other. By reason of their impact the drops of water are broken into much finer particles than could be effected by the action of the nozzles alone. The finer the spray the greater will be the cooling effect.

This method of grouping the nozzles also increases the circulation of air among the spray particles, due to the accumulative driving action of the sprays in the same group, resulting in making the system entirely independent of the natural circulation of the air over the pond, and it is found in practice that equally good results are obtained on calm as on windy days.

Another advantage of this arrangement is that it permits of operating the sprays at a lower pressure than would otherwise be possible, resulting in a large saving in power. A typical arrangement of nozzles is shown in Fig. 3.

Evaporation and Drift

AS a large part of the cooling is effected by radiation and convection, the loss of water from evaporation is small. With single spraying it will average about ¾ of 1 per cent of the water sprayed. On hot days it might amount to 2 per cent but such occasions are rare and the above average can be safely estimated on for the amount of make-up water necessary.

The drift from the spray system is practically negligible, owing to the low operating pressure, usually 10 lb. or less per square inch. At operating pressure exceeding 10 lb. a fine mist is formed, but at a lower pressure practically all the spray settles within 20 ft. of the spray nozzles.

In the spring and fall the final temperature of the water after spraying will average about 8 deg. above that of the air, while in the summer it will be cooled within a few degrees of the air temperature. On very

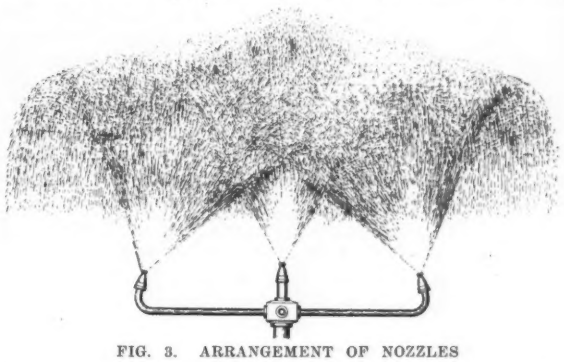


FIG. 3. ARRANGEMENT OF NOZZLES

hot days the final temperature of the water will be several degrees colder than the air temperature. In the West and South, where the temperatures are high and the per cent moisture low, much better results are obtained. Where it is desired to reduce the temperature of the water a greater amount, special arrangements can be made to cool it below the temperature of the air at all seasons.

FIG. 4. LOG OF SPRAY-COOLING POND 5000-kw. STEAM TURBINE PLANT IN NEW ENGLAND

		8 A.M.	12 M.	4 P.M.	
January	T_1	68°	73°	73°	
Hum.	T_2	48°	53°	53°	Clear
62%	T_3	8°	14°	20°	
February	T_1	75°	81°	83°	
Hum.	T_2	54°	61°	63°	Cloudy
83%	T_3	29°	33°	35°	
March	T_1	79°	86°	90°	
Hum.	T_2	58°	66°	70°	Clear
50%	T_3	30°	50°	43°	
April	T_1	85°	90°	92°	
Hum.	T_2	66°	71°	73°	Clear
55%	T_3	56°	68°	68°	
May	T_1	89°	94°	97°	
Hum.	T_2	70°	75°	78°	Clear
72%	T_3	65°	72°	70°	
June	T_1	107°	111°	116°	
Hum.	T_2	78°	83°	85°	Cloudy
90%	T_3	57°	68°	68°	
July	T_1	108°	118°	118°	
Hum.	T_2	90°	93°	93°	Clear
70%	T_3	90°	98°	102°	
August	T_1	112°	114°	116°	
Hum.	T_2	88°	89°	90°	Cloudy
84%	T_3	72°	74°	79°	
November	T_1	89°	90°	88°	
Hum.	T_2	62°	64°	63°	Cloudy
70%	T_3	27°	33°	34°	

Operating Pressure 11 lbs. per sq. inch.
T_1 = Temperature of discharge water, in degrees Fahr.
T_2 = Temperature of water after spraying, in degrees Fahr.
T_3 = Temperature of surrounding air, in degrees Fahr.
Hum. = Humidities taken at 8 P.M.

Size of Pond

IT is customary to keep the spray lines 15 ft. or more from the edge of the pond. For spray ponds of 1000 kw. capacity allow 1 sq. ft. of pond surface for every 200 lb. of water sprayed per hour. For spray ponds over 1000 kw. up to 5000 kw. allow 1 sq. ft. for every 250 lb. of water sprayed per hour. For ponds of small size a greater allowance will be necessary. No cooling advantage is gained by making the pond deeper than 3 ft. An earthen pond without expensive construction usually meets all requirements.

AIR LIFT WELLS AT ST. PAUL

Problems Met and Results of Test

FOR a long time pumping with an air lift has labored under several handicaps which have prevented its taking the proper place among the engineering problems of the commercial world, which its merits would warrant. One of these handicaps has been the facility with which piping has been placed in wells and certain results obtained, without regard to its proper proportioning for the work to be done. Then, many a plant engineer has inserted some kind of a turned up pipe nozzle, and, securing an improvement upon the first crude installation, imagines that he has solved the problem. Then, again, many assert that all that is necessary is to convey the water to the proper depth and any kind of nozzle or opening will do the work.

Another handicap has been caused by the compressor people themselves, who have only thought of the compressor sales and have not followed up the installation and seen that it was properly done, letting well enough alone as long as the customer was satisfied.

For many years after Dr. Phole brought out the theory of the formation of alternate plugs of air and water, this idea has been followed, care being taken only to obtain sufficient submergence to secure the best results, and when an over-all efficiency of 25 per cent was secured, they were more than satisfied.

In speaking of efficiency, we mean the i.hp. in the steam cylinders, taking account of the friction and volumetric loss in the compressor, and the loss in friction and temperature by conveying the air from the compressor to the pump in the well as compared to the foot pounds of work done.

As an indication of what is being accomplished with air lift wells, the report of the superintendent of construction, L. W. Rundlett, of the Board of Water Commissioners of St. Paul, Minn., is interesting. The equipment at St. Paul consists of 6 standard No. 12 Harris 20th Century pumps with 10-in. well taps, adjusting valves and separators giving 733 gal. each per minute; 6 towers 27 ft. to 28 ft. high upon which are mounted 5 by 6 ft. tanks; 1 Ingersoll-Rand Class O C compressor compound steam cylinders, 18 by 34 by 27, compound air cylinders, 18¼ by 30¼ by 27, and 1 500-sq. ft. Wheeler surface condenser and air pump. The plant is installed at the McCarron Lake Station and is intended for summer operation to augment the lake supply. An abstract of the report follows:

"About a year ago it became evident on account of the unusual conditions of rainfall last year (the total precipitation being a little more than 10 in.), that there was great danger of exhausting our water supply from the lake system, particularly so should the same conditions extend over another year. Means were taken to utilize our lake supply to the fullest extent and after giving careful consideration to available sources for additional supply, it was finally decided to put down a system of artesian wells at the McCarron Lake Pumping Station. The location at this point at the end of the conduit line and at the pumping station seemed the most favorable.

"There being no time to make a preliminary boring, a contract was let at once to sink 6 12-in. wells to such depth as might be necessary to obtain a supply of water. Five of these wells were sunk to a depth of 700 ft., and one well to a depth of 1000 ft., in the hopes of increasing the amount of water, but it was found that the increase in depth did not warrant the expenditure in the other wells. The water rose to an average level of about 18 ft. below the surface. A test was made on 2 wells and showed an excellent supply of water, both in quantity and quality. A contract was then let for the pumping plant. Under the existing conditions, it seemed expedient to place a separate unit at each well and to deliver the water through a pipe system to the terminal chamber where it could be used on both high and low service.

AIR LIFT WELLS AT McCARRON LAKE STATION

"Bids were received for installing an air plant or an electric plant, each bidder guaranteeing the efficiency of the plant. Robinson, Cary & Sands Company was awarded the contract for installing an air plant. By the terms of the contract, the addition to the power house for the compressor and an additional boiler were installed by the Board of Water Commissioners. All the physical conditions developed almost exactly in accordance with our anticipations, and the plant is now in successful operation. Under the terms of the test, the Board was to furnish steam to the compressor at 125 lb. pressure. The amount of steam used was determined by the measurement of the condensed water. The heat units of the steam consumed less the heat units of the condensate multi-

plied by the foot pounds in a pound of steam were to be considered the power furnished. The number of pounds of water pumped multiplied by the height water was raised were to be considered the work done. The amount of work done divided by the power furnished determined the efficiency, which was guaranteed to be not less than 4.83 per cent with a penalty of $100.00 for every one-tenth of 1 per cent below this standard and a bonus of $100.00 for every one-tenth above this standard.

"The result of the test was as follows:

Duration of test from 8 A. M. to 5 P. M.	9 hours
Average r.p.m. of compressor	80.26
Average steam pressure gage lb. per sq. in.	126.4
Average vacuum referred to 30 in. barometer	26.9 in.
Total pounds of condensed water	35,651
Average temperature of condensate	101.5 deg. F.
B.t.u. per pound of steam at average pressure	1189.7
B.t.u. per pound of condensate	69.1
B.t.u. consumed	1120.6
Average cubic feet water per second over weir 6.350,000 gallons per day	9.78
Average total head in feet	76.83
Total foot pounds water delivered ÷ Total foot pounds steam consumed; efficiency	4.90%
Efficiency covered by contract	4.83%

"The test was made using the new 78-in. boiler. No effort was made to run a boiler test, as it would not figure in the results. The total amount of coal consumed was 4947 lb. This would be equivalent to about 6.6 tons on a 24-hr. run. In starting the test, the first hour 617 lb. were burned on the grate, while the last 2 hr. there was an average of only 344 lb. used. I am very confident that as the firemen become accustomed to the boiler and with careful firing, the plant can be run on 5 tons of coal a day, which, at a cost of $5.00 per ton, would amount to $25.00. I should estimate that $10.00 per day ought to cover all other running expenses, making a total cost of about $35.00 per day. Certainly an excellent showing for the conditions of work.

"McCarron Lake Station well plant Air Lifts. In operation from June 12, to November 29, 1911:

Total gallons pumped in 1911	885,528,224
Total pounds coal consumed	1,811,461
Ashes, clinker, etc.	153,395
Total pounds of coal consumed (combustible)	1,658,066
Percentage of ash in coal	8.47%
Gallons pumped per pound of coal (actual)	488.8
Gallons pumped per pound of coal (combustible)	534.4
Average duty in foot pounds per 100 lb. coal	31,445,500

"Coal for changing boilers deducted in above."

In the record of the official test run at the McCarron Lake Station in July, 1911, the total lift allowed was the necessary head to flow the water into the receiving basin, or 76.83 ft. the actual lift from the surface of the water in the wells when pumping to point of discharge was 81.725 ft., as shown by record below:

Record Test at St. Paul, Minn., July, 1911

Well Nos.	1	2	3	4	5	6
Diameter in.	10	10	10	10	10	10
Depth ft.	700	1000	700	700	700	700
Static head ft.	19	20	12	20	19	19
Drop ft.	28.6	33.35	41.35	33.35	34.35	34.35
Elevation ft.	30	29	30	29	29	30
Total lift ft.	77.6	82.35	83.35	82.35	82.35	83.35
Submergence ft.	146.4	140.65	140.65	140.65	140.65	140.65
100% ft.	224	223	224	223	223	224

Average lift	81.87 ft.
Average submergence	141.61
Percentage of submergence	63%
R.p.m. Compressor	80.26
Pressure on receiver	72
Indicated horsepower	239.7
Gallons per minute pumped	4401
Theoretical horsepower	90.98
Efficiency	38%

PLACING AIR PIPES IN SHAFTS

EXTENSIONS of the compressed-air mains in the Champion shafts of the Copper Range Consolidated Co., in the Lake Superior copper country are made in 200 ft. lifts. The work is commenced by placing a tee in the shaft opposite the station at the bottom of the lift, then carrying up the piping for 200 ft. to connect with the air main already in position.

The tee at the lower station is securely fastened by an iron yoke to a carrier timber. The pipes are then lowered and put together until the next level above the station is reached. There another tee is put in the line, immediately above and below which yokes are used, both to anchor the main and to prevent swinging at that point. When this tee has been put in place the other pipes are lowered and, by using a pipe of the necessary length, the top of the extension is brought to within 6 or 8 in. of the bottom of the main already in place. A flange is screwed tightly home on the upper end of the top pipe and yokes are attached to anchor the line in position.

The connection with the part of the main already in place is made after 1 p. m. on Saturdays, at which time no drills are running in the mine, so that the air can be shut off without interfering with mining work. Jacks are placed under the lower end of the extension pipe and the yokes are loosened so that all the weight comes on the jacks.

The blind flange on the lower end of the part of the shaft main already in place is removed. The flange on the upper end of the extension is turned in the direction of unscrewing so that the bolt holes in upper and lower flanges are in line. The little loosening usually necessary does not cause leakage. Then the 200-ft. length of pipe is raised by the jacks until the flanges come tight together. The flanges are then bolted, usually with a gasket between to make a tight joint. The yokes, of which there are two for each 100-ft. length of pipe, are then tightened to hold the main in position.

During the operation, large wrenches are used to prevent turning of the upper part of the line when the extension is being raised. Making the connection takes an hour; 2 men are needed at the jacks, 4 at the yokes and 2, with the boss timberman at the point where the connection is made.—Engineering and Mining Journal.

STATISTICS OF CEMENT production in 1911, prepared by Ernest F. Burchard, of the United States Geological Survey, shows an increase over 1910 of only about 1,500,000 barrels. The increase in quantity is the smallest recorded within the last 13 yr. and the fact that the total value showed an actual decrease indicates that trade conditions were not as satisfactory in 1911 as in 1910.

The total quantity of Portland, natural and puzzolan cements produced in the United States in 1911 was 79,547,958 barrels, valued at $66,705,136. Compared with 1910, when the production was 77, 785, 141 barrels, valued at $68,752,092, the year 1911 showed an increase of 1,762,817 barrels, or 2.27 per cent. in quantity, but a decrease of 2,046,956, or 1.48 per cent. in value. The total production of Portland cement was 78,528,637 barrels, valued at $66,248,817. This quantity reduced to tons is equivalent to 13,321,822 gross tons, valued at $4.97 per ton. As compared with the production of Portland cement for 1910, which was 76,549,951 barrels, valued at $68,205,800, the output for 1911 represents an increase in quantity of 1,978,686 barrels, or 2.58 per cent.

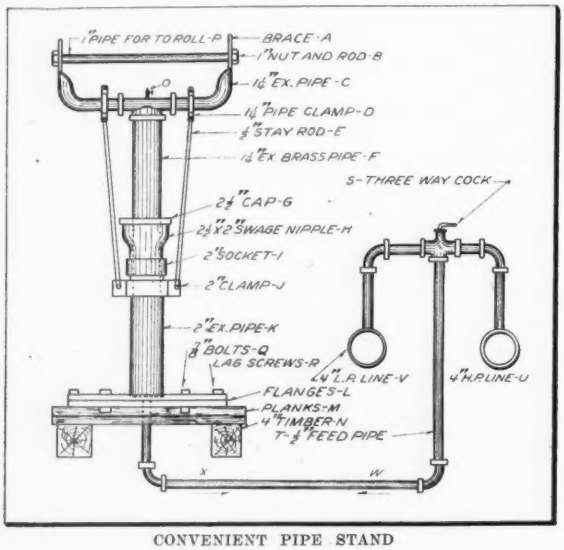
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

HYDRAULIC PIPE STAND

ILLUSTRATED in the accompanying drawing is a crane or pipe stand which I designed and made out of pipe and fittings and put in the shop. It is giving better results than any other which I have seen or used and requires no attention whatever.

The stand is worked by hydrualic pressure, or can be used with compressed air if no water pressure is available. It consists of the following parts: A is a portion of C which extends above the pipe to prevent the pipe from rolling off. B is a stay bolt going through C. C is a U-shaped saddle made of 1¼-in. extra heavy pipe with the end welded up. D is a clamp around C to support the stay rods. E is a stay rod which helps to brace the telescope or plunger



CONVENIENT PIPE STAND

when it rises. F is 1¼-in. extra heavy brass telescope or plunger pipe. G is a 2½-in. cap which takes the place of packing gland. H is a 2½ by 2-in. swage nipple acting as a stuffing box. I is a 2-in. socket. J is a 2-in. clamp to support the stay rods. K is a casing pipe or dashpot pipe. L is 2 flanges joined together. MM are planks; N, 4 by 4-in. timbers; O, pet cock; P, 1-in. pipe as roller; Q, ⅞-in. bolts; R, lag screws; S, 3-way cock; T, ½-in. feed to crane; U, 4-in. high-pressure line; V, 4-in. low-pressure line; W, acts as feed and discharge from 3-way to crane.

This crane when down stands 36 in. from floor to the top of the roller; 4 ft. 10 in. high when water has raised it to the full capacity. The principal uses to which this machine is adapted is to rest pipe when it is being threaded in a machine. Sometimes it is advisable to have 2 behind the threading machine. They can be raised so the pipe is perfectly in line with the dies cutting the thread.

On large pipe it requires no lifting or slugging in order to level the pipe. All that is necessary is to operate the 3-way valve. After the thread is cut the stand can be lowered and used as a bench upon which to put flanges.

The pipe can also be turned end for end without any heavy lifting. In a great many shops they avoid work benches which become nuisances on account of so many workmen throwing everything on them.

The vise can be put on a post and concreted in and these cranes or stands used for the pipe to rest upon.

E. H. Marzolf.

GAS FURNACE FOR BOILER

I AM sending you 2 sketches of a boiler of which I had charge at one time and a description of it, which may be of interest to some of the readers of Practical Engineer. Figure 1 represents the boiler as it was originally installed. I will add here that the fuel used was natural gas and the burners, 4 in number, were placed as will be seen in Fig. 1 above the grate bars which were covered with brick so as to remove all possibility of any air coming from beneath them. There was also placed in front of the burners a baffle

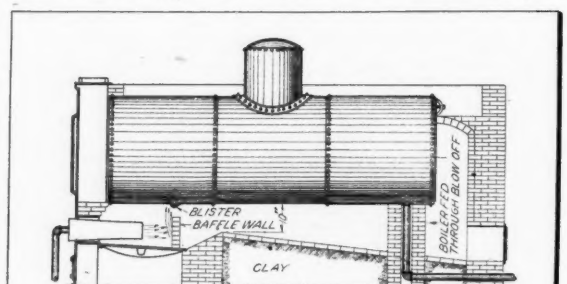


FIG. 1. ORIGINAL FURNACE ARRANGEMENT

wall made of fire brick which was intended and did thrust the flame against the boiler sheet. The boiler was fed through the blowoff which seemed to force the mud toward the front of the boiler and over the fire. Now, whether this was the case or not, one day when we had to force the boiler we discovered a bag at the point indicated in Fig. 1 and directly over the baffle wall.

Another thing that we noticed was that it was impossible to adjust the burners so as to prevent smoke issuing from the stack, and there was continually a coating of soot on the bottom of the boiler.

After discovering the bag we changed the setting as is represented by Fig. 2. In the first place we changed the feed pipe by tapping the boiler behind the dome and dropping a nipple down to within a couple of inches of the flues and carried it back to the combustion end of boiler and over to the side and

back, as is shown in drawing, to the front of boiler then over to the center and dropped it between the center row of flues.

We also took out 2 of the 4 burners and also the grate bars as shown by the cut, we then cut the bridge wall down and filled the space with clay, in just the reverse from the original setting, and placed the remaining 2 burners in the ash pit with a downward slope so that we could get the flame as far as possible from the boiler. The result was that we fired the boiler with the 2 burners with a consumption of

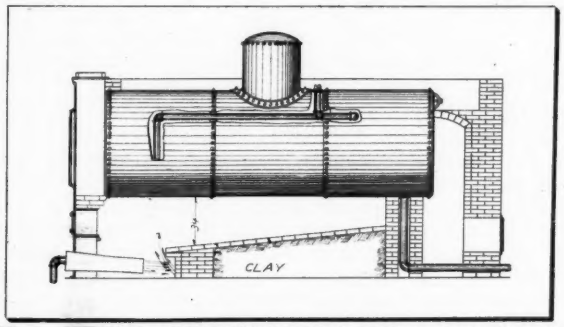


FIG. 2. FURNACE ARRANGEMENT WHICH GAVE SATISFACTION

less fuel than we did in the first place and we had no more trouble with smoke issuing from the stack or soot on the lower sheet.

I am sending this thinking possibly some of the readers may have had a similar experience and that some of them will offer criticisms which will be received with interest. C. S. Robinson.

THE CONSULTING ENGINEER

WHY do so many operating engineers insist on depreciating the services of consulting engineers or other experts? Nearly every magazine we pick up has an account of how the manager of a plant had sense enough to call in an expert, the engineer "kept his mouth shut" and as a result the expert missed the important points to the glorification of the engineer. Then the plant ran on with the same old extravagance. Did this raise the engineer's pay?

I once drew plans for the installation of a power plant specialty, and after a few months was called to a distant city to find out why it did not work. Upon arriving the engineer would barely answer questions and even remarked to others that "the expert better find out for himself" and that "I am not paid for doing his work."

It took me 2 days (at the plant's expense) to find out that a certain "useless" drain had been taken out and plugged up.

If this engineer had explained where he had not followed out the specifications it would have been found in a few minutes and as it was I had to make a report of my long stay to the owner. Did this help the engineer?

The doctor or lawer does not hesitate to call in help on a difficult case and where the consulting man keeps going from plant to plant he can certainly carry around good ideas that we would never get in the limited experience of our own plant.

By nature of his work the expert wears good clothes and keeps clean but that doesn't make him a dude. One of the best consulting engineers in this city spent 25 yr. in overalls and he really knows what the man in the plant has to encounter, besides his experience is worth a good sum to his clients.

At our plant we spend $10 once in a while for expert services and at the end of the year a few hundred dollars saved is more apt to reach me than if it went to the coal and supply dealers.

But when you do call such a person in, tell him all you know about the subject and if you do not understand his report or think it foolish make him explain and then you will be the wiser man.

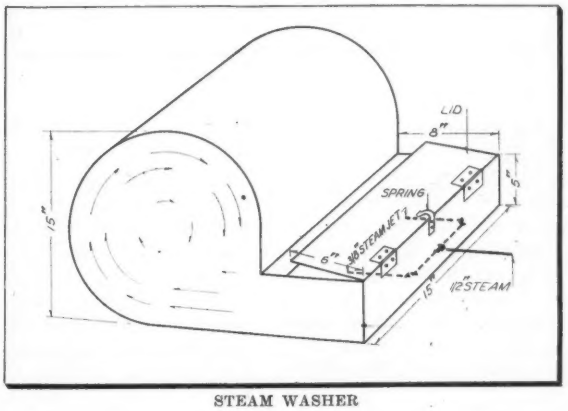
When you phone for a doctor do you say "Well here I am, find out what ails me and cure it?" Not much, you tell him all your troubles and then some. Treat the Power Plant Doctor the same way, you will find him a valuable friend instead of an enemy.

A. Karreman, Jr.

WASHING OVERALLS

SEVERAL articles have appeared recently in Practical Engineer on apparatus for washing overalls. We have tried out several and find the one here described the simplest and best.

The washer shown in the drawing herewith uses steam only, and will wash the dirtiest garment in 2 or 3 minutes. The garment is soaked in soapy water and without wringing is placed in the washer and steam turned on. When the garment attains a speed of



STEAM WASHER

about 50 or 60 r.p.m., enough steam has been turned on. If one is particular the garment might be rinsed out a little after washing.

The width of the lid is 2 in. narrower than the opening. The sides of the washer and the cross piece through which the steam pipe passes, are made of 1½-in. lumber. A sheet of galvanized iron 15 in. wide and long enough to go around the bottom and circular sides of the machine is nailed to the edges of the wooden sides and cross piece. The lid is of 1-in. board, and the jets are reduced to ⅜ in. and flat at the end.

C. E. N.

SHIFTING ECCENTRIC

A FRIEND asked me to look over his engine, which he said was not acting just right. Upon entering the plant I found a single non-condensing Corliss, with a single eccentric. It would cutoff for 3 or 4 revolutions then take steam full stroke for 3 or 4 revolutions. He said he changed the governor rods every way and found he was making matters worse. I called again Saturday afternoon, when the mill was stopped and we took the back bonnets off the valves, and found we

could cut down on the lap of the valves, both steam and exhaust. This allowed the eccentric to be put back on the shaft or nearer to the crank and have the proper amount of lead which in turn allowed a later cutoff under the control of the governor, the cutoff was increased from 5/16 to 6/16 in. the latest point under the control of the governor.

When the engine was started Monday morning it not only cut off every time automatically but the regulation was better and the fireman did not have to

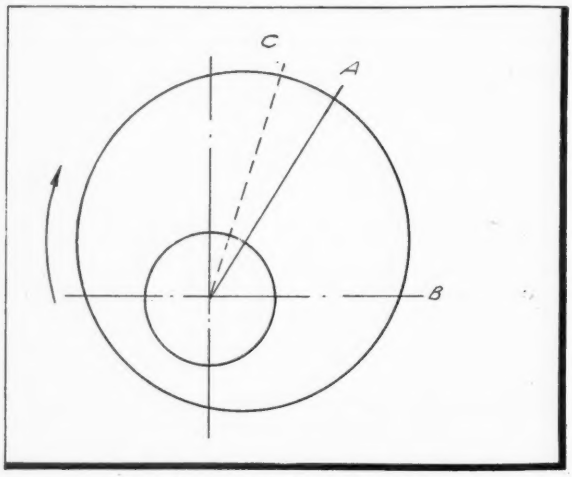


DIAGRAM OF ECCENTRIC POSITION

shovel as much coal for the same amount of work. It will be seen that with the eccentric set at A the knock off cams were under the control of the governor only while the eccentric was traveling from A to B which was hardly enough to carry the load. When the eccentric got to B, there was no further movement of the eccentric in that direction, so the valves were not tripped off and took steam full stroke for a couple of revolutions. This speeded up the engine and the governor ascended and brought the knockoff cams into play and tripped the valves. Thomas Sheehan.

OIL IN BOILERS

ON page 726 of the July 15 issue are 2 letters on the subject of oil in boilers. Mr. Duggan is positive that oil does cause bags and blisters, and Mr. Pierce proves by experiment (to his own satisfaction at least) that oil will not cause bags or blisters. My experience, covering some 12 yr., has lead me to believe that both are partly right and partly wrong. When oil first enters the boiler with the feed water its specific gravity is less than that of the water and it floats. But due to the violent ebullition of the water it comes in contact with particles of scale forming matter, principally calcium carbonate and calcium sulphate, both of which are heavier than water, and which are being constantly thrown down, and some of it at least adheres to these solids and eventually comes in contact with the tubes or shell to which it sticks.

It has been my experience in some plants where the exhaust steam is returned to the boilers to find, on opening the boilers for cleaning, a spongy coating from 1/16 to ¼ in. thick of oil and scale together on the tubes, which was soft, and came off very easily. Although the boilers were blown down, both surface and bottom, several times a day, the mixture of oil and scale gradually collected on the tubes and shell while the boiler was in operation. Furthermore the greater part of the oil is usually found on the lower tubes and lower part of the shell, and not in the upper part, as would be the case if the oil remained on top, as stated by Mr. Pierce.

Mr. Pierce's experiment of pumping oil into the boiler and blowing it out through the surface blowoff is of little value, because the oil was not given time to become attached to any of the scale forming matter, but rose to the top and was immediately blown off. But had he put the same amount of oil in the boiler and left it there for a week with the boiler in operation and being blown down 2 or 3 times a day, as is the usual case, and with the usual type of blowoff, he would have found much of it sticking to the lower tubes mixed with scale as a soft spongy mass.

Oil of itself in a boiler will do no harm other than increase the coal consumption, due to its insulating qualities, unless there is a great deal of it, but in connection with scale it will collect in the lower tubes of a water-tube boiler or over the fire sheet of the tubular and cause the tube or plate to become overheated, thereby causing a bag or blister. I have yet to see a case where oil was present that scale was not there too, and the danger of bagging the boiler was greater than it would have been if the oil had not been present. The average type of surface blowoff as found in some water tube boilers is of no use whatever for the purpose for which it is intended. In boilers of the Heine and Geary type, the feed water enters one end of a section of 8-in. pipe placed inside the steam drum, with a hole cut in the top for the water to overflow into the drum, and the surface blowoff is connected to the other end of this section of pipe, or mud-pan, as it is called, and when the surface blowoff is opened, instead of blowing the scum and oil from the top of the water, it only blows out a portion of the feed water before it really enters the boiler. A better way is to connect the surface blowoff to a floating funnel that extends nearly the full width of the drum at the water line, as well as to the mud-pan, which will catch some of the scale forming matter, and if frequently used or made to work automatically will be of much help in getting rid of scale as well as oil.

J. C. Hawkins.

IN regard to oil causing bagging of boilers, will say that I have had a little experience personally with this trouble. Some few years ago I had charge of a small plant containing one 36 in. by 10 ft. and one 48 in. by 12 ft. return tubular boilers. The smaller was an old boiler and when I took charge was somewhat scaled; the owners were in the habit of putting a couple of gallons of crude oil in whenever they cleaned the boiler and before they would put any water into it. This had been done without any serious effects, but over my protest and when they installed the other boiler, which was a second-hand boiler, but free from scale, I again protested against the use of crude oil, but was told to use it as before. I did so for several times, when to my horror one day, when I went to throw on coal, I discovered a genuine bag about 18 in. in diameter and about 1⅜ in. drop and I have always thought that the only thing that had prevented the same thing from occurring to the other boiler was that the scale prevented the oil coming into contact direct with the sheet of the boiler. And I think that this is the reason some have trouble from bagging caused from oil in their boilers and others do not.

I think that any scale, no matter how thin it may be, will prevent a boiler from becoming bagged from the effects of oil. I think as John Pierce, page 726, July 15, '12, number, that if the oil gets in through a feed line, one that is fed on top, that there possibly will be no ill effects from oil, as it will float on top, but I would not take a chance of letting it get into a boiler through a feed line that was connected through a blow-off. But nevertheless I should advise keeping oil out of the boilers, if possible, and I do know that the boiler of which I speak was bagged from the effect of oil on the bottom sheet as there was no scale whatever to speak of, neither was there any mud in the boiler; it had been cleaned only about 4 days before. One way that anyone can satisfy his own curiosity in regard to this problem is to put a few drops of oil in an iron plate, then wipe off and then put a little water on where the oil was and see what effect the water will have adhering to the iron. I think this is what happens in the boiler, the sheet becomes overheated by the water not adhering to the plate, which causes what we term a bag. Roy Stahl.

REFERRING to letter by John Pierce, page 726, July 15 issue of Practical Engineer, "Does Oil Cause a Bagged Boiler?" I would say that Mr. Pierce runs away from the facts. Oil will bag a boiler just as sure as it gets the required time and proper conditions to accomplish the work and that, too, right under the skimmer, because if the circulation is what it should be, the oil will not accumulate and remain on the surface of the water, but will circulate with the water. This most certainly would be the case when the boilers are supplying steam, and the circulation more hurried and violent than at any other time, and the hot surfaces will pick up and carbonize all the oil he put into his boilers in less than 10 minutes.

I use crude oil in our boilers to keep them free of scale, and it does the work wonderfully well, but I do not use it without judgment, and watch my boilers mighty closely for deposits of carbonized oil. If the crude oil Mr. Pierce puts into his boilers stayed on the surface of the water, then it could not interfere with the accumulation and distribution of scale on the surfaces of his boilers. And also if it were not for the deposit and shelling off of the scale in the boilers, where oil is used to prevent excessive accumulation of scale, there would in time be on the surfaces a carbonized oil deposit 1 in. thick.

The reason why oil will bag a boiler is because its residue, which remains after the gases of the oil are driven off, adheres to the plates, and in the form of a hard brittle film, the underside of which has a promiscuous distribution of little saucer-shaped undulations or blisters which is caused by heat on the film of oil. These blisters increase the insulating power of the film and it is plain and easy to see that if this deposit of residue or carbonized oil is not interfered with it will soon be powerful enough to impede transfer of heat sufficiently to cause the plates to overheat.

For us who use crude oil as a scale eliminator its property of floating is a happy one, otherwise we could not use it in our boilers, for it would either go to the mud-drum or camp some place in the crown sheet, all in a bunch, too, very likely. If Mr. Pierce will use a powerful glass in examining some of his scale he will find on some of it a very thin film of carbonized oil which was picked off of the plates by the piece of scale, the film being so thin and comparatively brittle, and its adhesive characteristic so weak on account of the little blisters in it, that the vibration, expansion and contraction of the boiler loosens the film, and the scale consequently falls off with the film of carbonized oil. At least my observation has convinced me this is the case. Thos. C. Robinson.

PUMP GOVERNOR

WE have a 3000-gal. tank on a tower 35 ft. high, which is supplied with water by a steam deep-well pump, this pump has been hard to set so that it would keep the tank full, half of the time the tank is running over and the other half we have no water.

To get around this, I rigged up the regulator shown in the sketch, this is made out of an old ice cream package can, holding about 2 gal., I soldered a pet cock on the bottom of this, then attached the lever to the globe throttle valve of the pump, and hung some old scale weights on the other end. Running a ¾-in. pipe from the top of the tank down so that it would over flow into my bucket on the throttle valve completed the outfit. When the tank runs over it flows down into this bucket and causes it to sink down, shutting down the pump. The pet cock is set to empty the bucket in about 20 min., when the water gets out, so that the weights on the other end will fall they open the valve and start the pump and the same thing is repeated every time the tank gets full, which is about every 2 hr.

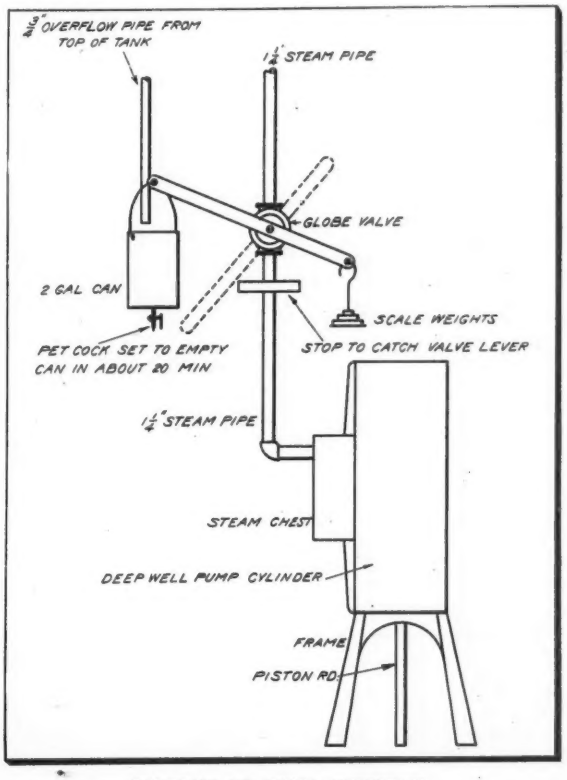


DIAGRAM OF PUMP GOVERNOR

We don't have so much slop around the outside of the building now and I can read Practical Engineer without jumping up and starting or stopping the pump. T. M. Street.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

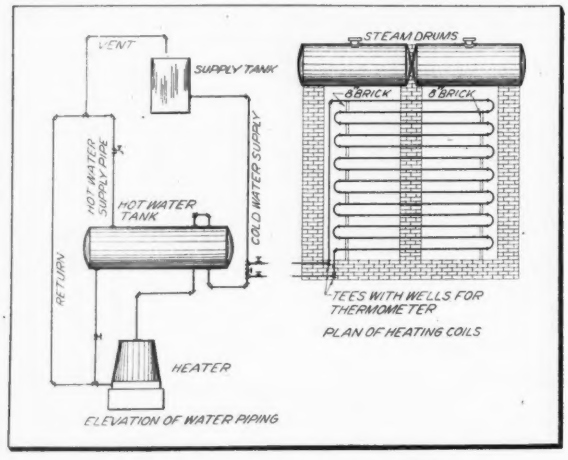
Heating Water

AT our plant, which is in a large office building, we have a circulating hot-water system which supplies hot water for cleaning and toilet purposes and also for a soda fountain and barber shop.

We increased our capacity for heating the water by installing a 300-ft. coil of 1½-in. pipe in 14-ft. lengths with return bends, on top of the brick work over our boiler tubes, thus utilizing the waste heat that came through the bricks.

We have 2 B. & W. 150-hp. boilers with the steam drums across the back, which leaves a good flat surface over the tubes.

The pipes are connected with by-pass valves to cold supply from tank on roof, to bottom of hot water tank, to bottom of heater, to top of hot water tank, to hot supply, etc.



ARRANGEMENT OF TEMPERING COILS

Last winter our heater cracked, which we think was largely due to feeding cold water in the bottom of heater and the expansion strains caused by having a fire hot enough to heat it quickly. As the pipes come and leave the boiler top we have 2 thermometer wells made by soldering a ½-in. brass nipple in a bushing screwed in the top of a tee, so that we can see the difference in temperature at any time. As the coil was not installed until late spring we did not have a chance to have a hot fire in our boilers, but still we raised our water from 60 to 90 deg., which made a great difference in the coal used and will cause less strain in our heater.

After installing pipes we covered and packed well with 6 in. of sand and also put 8-in. bricks between the return bends.

We think this coil would work well with a boiler feed water heater as it takes the chill off the water.

A. J. Zimmerman.

Packing for Piston Rings

I HAD an experience with our boiler feed pump the other day that may prove of value to some of the other engineers. It is a Snow duplex, and while running failed us altogether, or would run on one side very slowly, not enough to give us the water we must have. I found upon taking off the heads that the piston rings on one side were broken all to pieces; the nearest machine shop is 15 miles away and it seemed evident that we were facing a shut down for 24 hr. at least.

While scratching my head and trying to solve a way to get out of this I thought that I would try some of our duck water packing, I had some of this ⅝-in., which just fitted the grooves for the rings. Then taking some of the packing and cutting it into rings, with beveled ends I fitted them in place and put the piston back, put on the heads and turned on steam; it started up and has run now for over a month with no other rings; we have the new ones here, but I shall not stop to put them in as long as the packing rings hold out as well as they are doing.

T. M. Street.

Special Lock-Nut to Secure Piston Rod

IN answer to Student's question in June 1 issue whose piston rod screwed itself out of crosshead, I am submitting herein a scheme for securing this connection between the piston rod and crosshead which we are making for that purpose and to be used on our engine. The sketch needs but little explanation with it. The extension from the main lock-nut is threaded on the inside the same as the the main portion of the

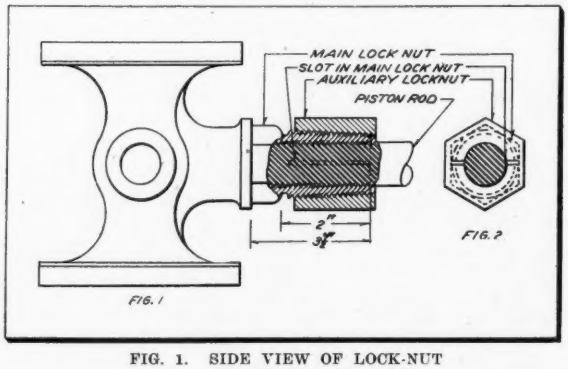


FIG. 1. SIDE VIEW OF LOCK-NUT
FIG. 2. END VIEW OF LOCK-NUT

nut, the extension is given a tapered thread on the outside surface, over which the extension nut, or auxiliary lock-nut works. The auxiliary nut of course is threaded tapered, also, same as thread on outside surface of main lock-nut extension, except that the diametrical distance between the bottom of the threads on the auxiliary lock-nut is 3/64-in. less than the diametrical distance between the tops of the threads on the outside surface of the main lock-nut extension.

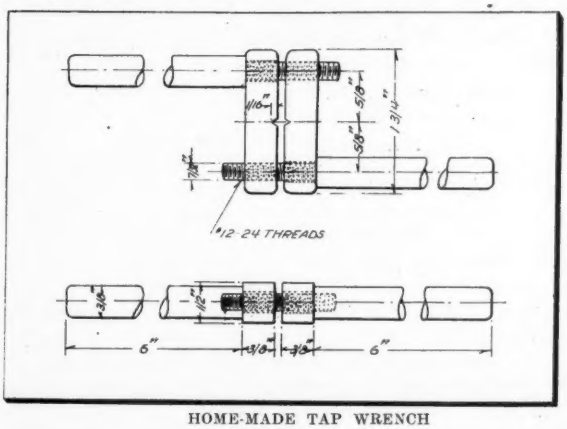
The extension of the main lock-nut is slotted in 2 places on diametrically opposite sides so as to allow the auxiliary lock-nut to bind or tie the main lock-nut extension to the piston rod, the slots of course being necessary so that the extension will give or spring a little as the auxiliary lock-nut is forced on with a large wrench which will cause the extension to take the never-let-go grip on the rod.

The threads on the piston rod into which the threads on the inside of main lock-nut extension are forced by the auxiliary lock-nut when screwed home, also the threads on the outside surface of the main lock-nut extension, and the threads of the auxiliary lock-nut are shown by dotted lines in sketch. We are making both the main and auxiliary lock-nut out of steel. The length of the extension on the main lock-nut depends, of course, on the distance between the face of crosshead and piston rod connection, and the stuffing box, also on the number of extra threads on the piston rod, i. e., the number or distance of the threaded portion of the piston rod not covered by the ordinary lock-nut when it is in its proper place on the piston rod. We have 2 in. for the extension and 1½ in. for the main lock-nut, as shown by sketch.

Thos. C. Robinson.

A Simple Tap Wrench

ACCOMPANYING illustration shows a tap wrench that can be quickly and easily made up out of stock materials. The handles are made from ⅜-in. cold rolled steel, with the ends turned and threaded as shown. For the clamping jaws, rectangular steel measuring approximately ½ by ⅜ in. is used. These jaws



HOME-MADE TAP WRENCH

have V shaped slots 1/16 in. or more deep cut in them to hold the tap. The sides of the V's should make an angle of 45 deg. with the center line; i. e., an angle of 90 deg. with each other.

For the larger sizes of taps the dimensions of the wrench illustrated should be increased a sufficient amount to give the proper leverage when using the wrench.

H. M. Nichols.

When Oil or Grease Fails

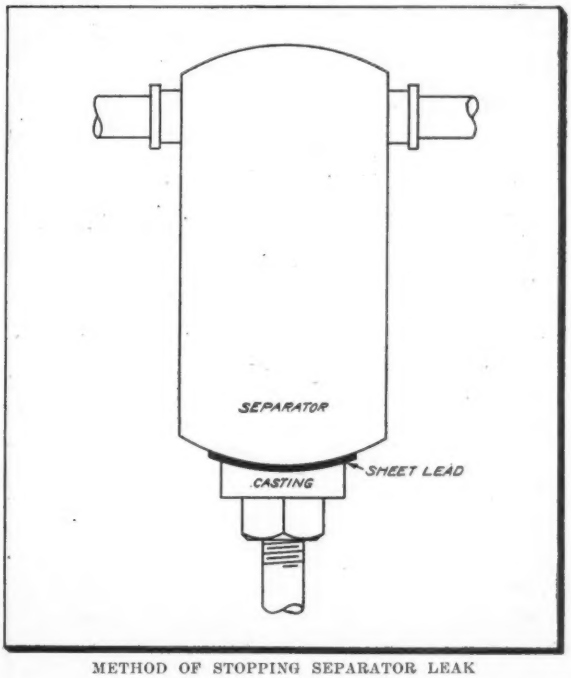
A 50-TON ice machine is cross-connected with a Corliss engine in a plant where I am employed. The crank-pin on the ice machine side from faulty alignment due to its improper construction, would run hot at irregular intervals when least expected causing a great deal of care and worry at all times while on duty. The only precaution from shutting down, that I always keep is a separate oil can containing lubricating oil and graphite. This I use just as soon as this crank pin commences to run hot, when both the oil and grease have failed to do their duty. I would run the engine slowly, and after removing the grease cup from crank pour this oil upon the bearing; within a few minutes after applied, it would commence to cool down. I have found no other lubricant than graphite when a bearing is heated to a high temperature that would prevent a shut down.

L. A. D.

Stopping Separator Leak

A STEAM separator in a nearby plant had given trouble from leaking and efforts to repair had heretofore proven fruitless. The leak was in the pipe running out from the bottom and was apparently due to poor threads or defective material in the lower head, for putting in new pipes with perfect threads did not help.

Working on a different plan, another repair was effected which bids fair to last for good and for which I helped get out parts. A casting about 8 in.



METHOD OF STOPPING SEPARATOR LEAK

in diameter by 1¼ in. thick was turned out concave on 1 side to fit the curve of the head. The pipe entering the head was taken out and a straight thread cut back from the end to which a nut was fitted. The casting was bored out just to go on the pipe.

Thread and casting were liberally smeared and then assembled, inserting, however, a ¼-in. sheet lead gasket between casting and head. Screwing up pipe and nut as tight as possible and calking the lead completed the job.

D. A. Hawpson.

MORRIS ENGINEERING CO. of Philadelphia has bought the plant and the business of Geo. V. Cresson Co. which manufactures power transmission and mining machinery. The manufacturing of both companies will hereafter be carried on at the Cresson plant.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Steam Engine and Boiler Questions

WILL you kindly answer the following questions?

If the steam gage of a Manning boiler 30 ft. high is piped down to within 8 ft. of the floor, what connection should be made, and why?

2. What is the ogee ring for on a Manning boiler?

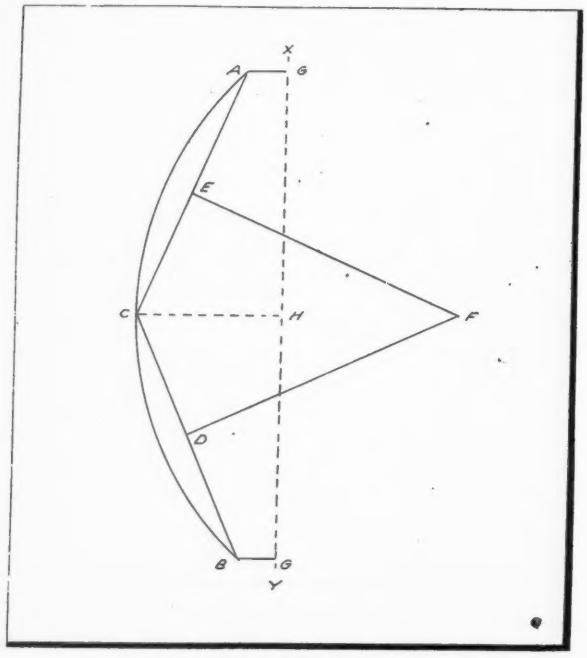
3. What is the safe working pressure of a cast-iron cylinder 36 in. dia., 5 ft. long and 7/8 in. thick? Please give example.

4. Please give rule and example of how to find radius of convex and concave boiler head.

5. What is an Adamson ring?

6. How do you figure the heating surface of a Babcock & Wilcox water tube boiler?

7. How is the piston of a single cylinder steam pump prevented from striking the head?



FINDING RADIUS OF BOILER HEAD

8. Please explain how the cushion valves on the steam cylinder of a duplex pump are connected.

9. Give example of how to figure size of cylinders for a triple expansion engine.

10. How can you tell by looking at them whether the headers on a Babcock & Wilcox boiler are cast iron or steel? R. R.

A. The pressure exerted in a vertical pipe by the water contained in it, is 0.43 lb. per ft., so if the steam gage is located 22 ft. from the top of the boiler, 30 — 8, the pressure at the bottom of the connecting pipe would be 22 by 0.43, which is approximately 9.5 lb. which the gage would register more than the actual pressure, and which would have to be allowed for when setting the gage.

2. The ogee ring on a Manning boiler serves the double purpose of permitting a larger amount of heating surface and grate surface on practically the same floor space as would be required for an ordinary vertical tubular boiler of the same overall dimensions, and also to provide an expansion joint in the shell of the boiler to relieve the strains set up by unequal expansion and contraction of the shell and tubes.

3. The tensile strength of the usual cast iron is 16,000 lb. although the iron usually used in cylinders of engines of large size will be somewhat more. Then the bursting pressure will be:

Tensile strength times thickness of metal in decimals divided by radius of cylinder.

Reducing this to figures we have:

$$\frac{0.875 \text{ in.} \times 16{,}000}{18 \text{ in.}} = 778 \text{ lb. bursting pressure.}$$

Then allowing a factor of safety of 10 lb. will give 778÷10=78 lb. as the safe working pressure.

4. To find the radius of a boiler head that is concave or convex, or "dished" as it is usually called, first by means of a straight edge as at x y, find the depth of the heat at c h, making allowance for the depth of the flange at AG and BG, then transfer these 3 points to a suitable board or paper either full size or to any convenient scale. Connect A and B each with C, and from the middlepoint on each of these 2 lines, erect the two lines EF and DF, perpendicular to the lines AC and BC, respectively, and where these 2 lines intersect, as at F, is the center to which the head is dished, which will be the distance CF.

5. Sometimes the furnaces of internally fired boilers are made up of a series of short sections of perhaps 18 in. long or so, and flanged outward. When these sections are riveted together a flat ring of iron or steel is inserted between the joints, which is called an Adamson ring. This ring is perhaps 2 in. wide and half an inch thick and the object of it is to have a calking surface as well as a means to allow for unequal expansion and contraction of the furnace.

6. Multiply the circumference of a tube by the length, in inches and divide by 144. This will give you the sq. ft. in one tube. Multiply this by the whole number of tubes. Add to this the square feet of the surface of the steam drums that are exposed to the fire. The surface of the headers which is exposed to the fire is usually not figured in as part of the heating surface.

7. On a single cylinder steam pump, a certain amount of lost motion is provided for in the valve driving mechanism so that the position of the piston with relation to the stroke can be determined closely

before steam is admitted to the other side of it for the return stroke and it is possible to adjust this lost motion so closely that striking clearance is reduced to perhaps as low as ⅛ in.

Increasing the lost motion, increases the length of the stroke and reduces the clearance, and decreasing the lost motion produces the opposite effect.

8. On duplex steam pumps of large size 2 steam ports are provided at each end of the cylinder and between these there is a valve controlled from the outside by means of which steam can be allowed to flow from one to the other in any quantity, or not at all, as desired.

When the piston is returning to a certain end of the cylinder, the exhaust steam is escaping by means of the inner port only and when the piston approaches the end of the stroke it covers this inner port and imprisons a certain amount of exhaust steam in the cylinder, which can escape only through the outer port and through the cushion valve to the inner port, and by regulating the cushion valve, just enough exhaust steam can be retained to cushion the heavy pistons at the speed at which it is desired to run the pump.

9. To give an example of the method of determining the cylinder dimensions of a triple expansion, when no data is given, it necessarily must be assumed.

Therefore, we will assume the following data:

Proposed indicated horsepower.....600
Proposed piston speed ..... 600 ft. per min.
Proposed revolutions per minute .. 100
Initial steam pressure at the throttle, 150 lb. gage, 165, absolute.
Vacuum 28 in. or 1 lb. back pressure, absolute.
Terminal pressure in l.p. cylinder, 5 lb., absolute.

Then the total expansions in the three cylinders will be 165 divided by 5, or 33 expansions, and the expansions per cylinder will be the cube root of 33, which is 3.21.

Then the theoretical volume of the i.p. cylinder will be 3 times vol. of h.p. The theoretical volume of the l.p. cylinder will be 3 times vol. of i.p., and theoretical volume of the l.p. cylinder will be 9 times volume of h.p.

But it has been learned from a series of tests conducted on a large number of triple expansion engines under a large variety of conditions, that there is a great loss in the cylinders and receivers, due to condensation, etc., and that the theoretical conditions are never attained. It has also been learned that under ordinary operating conditions as usually encountered, that these unavoidable losses have tended to cause a loop on the expansion line of the low pressure cylinder which was a loss, so in order to eliminate the extra expense of large cylinders that did not bring in a good return on the money invested in them, the cylinder ratios were reduced somewhat.

So we will reduce the total number of expansions to 31 which will be a fair average. With a cutoff of ¼ in the h.p. cylinder the ratio of expansion will be 4. Then the ratio of the h.p. cylinder to the l.p. cylinder will be the total expansions divided by the ratio in the h.p. cylinder, or 31 divided by 4, which gives 7¾.

Then, if the volume of the l.p. cylinder is 1, the volume of the i.p. cylinder will be 42.8 per cent of 1, and the volume of the h.p. cylinder will be 13 per cent of 1.

Assuming that all the work is done in the l.p. cylinder, it is found that it will require a m.e.p. of 21.5 lb. to develope the required power. Then the area of the piston will be found by multiplying the required horsepower by the foot pounds for one horsepower, and dividing by the piston speed times the m.e.p. Reducing to figures:

$$\frac{600 \text{ hp. times } 33{,}000}{600 \text{ ft. piston speed} \times 21.6} = 1540 \text{ sq. in.}$$

which is the area of the low pressure cylinder.

Then the i.p. cylinder will be 42.8 per cent of that or 630 sq. in. and the h.p. cylinder will be 13 per cent of it or 200 sq. in.

The circles corresponding to these areas is as follows:

1540 sq. in. = circle 44.5 in. diam.
650 sq. in. = circle 29 in. diam.
200 sq. in. = circle 16 in. diam., which is the area of the three pistons.

As the piston speed is 600 ft. per min., and the r.p.m. 100, then the stroke will be:

$$\frac{600}{100 \times 2} = 3 \text{ ft.}$$

Therefore, a triple expansion engine to deliver 600 i.h.p. under the conditions given, will have cylinders 16, 29, and 44.5 by 36 in. and it now remains but to design the engine around the data given, as a whole.

10. The general surface of cast iron is rough, similar to a sheet of sandpaper, while cast steel is more inclined to be smooth and in some respects the surface resembles malleable iron. When cast steel is chipped with a chisel it does not break off readily, but is tough and has all the appearances of wrought iron or steel, while cast iron is brittle when chipped and the fracture presents a grayish and crystalline surface. G. H. Wallace.

Heating System

WE are going to install a power plant that will be situated about 75 ft. from the main building. I would like your opinion on the size of pipe, or rule for size of steam connection to heating coils of different number of ft. of pipe to be heated by exhaust steam, also if it would be advisable to use a vacuum pump on return lines.

Of the rooms to be heated one will be about 75 ft. by 200 ft., and 2 rooms about 50 ft. by 50 ft., then their will be an office about 60 ft. by 60 ft. I think of heating office with live steam reduced to about 15 lb. pressure. W. R.

A. In figuring size of supply pipe to the buildings to be heated, it is first well to know the radiating surface to be supplied and that should be figured from the amount of wall and window surface of building which is exposed to the weather. Also if mechanical ventilation is to be installed, that should be taken into account. A good rule to apply where direct radiation is to be installed is this: Find the amount of glass surface in sq. ft. and divide it by 2; add the amount of exposed wall surface divided by 20 and to this add the cubical contents of the room divided by 200. This result will give the amount of sq. ft. of direct radiating surface needed.

It would be well to add 25 per cent to the result for windy weather and quick warming. By this rule, the radiating surface needed in the three buildings to be heated by exhaust steam should contain about 5000

sq. ft., that is, assuming the rooms to be 14 ft. in height. That 5000 sq. ft. of radiating surface will condense about 9.3 cu. ft. steam per second (as one sq. ft. will give off 250 B.t.u. per hr. which multiplied by 5000 and divided by 3600 equals 347 B.t.u. per sec. and 347×26÷970=9.3 cu. ft. of steam per sec.)

Now if we proportion the pipe so that the velocity of the steam through it shall be 50 ft. per sec., which is reasonable for that short distance (75 ft.) we will have a pipe area of 9.3×144÷50=26.8 sq. in. or a diameter of 5.8, so that a 6 in. pipe would be ample for the purpose.

A good thumb rule for determining size of mains for heating where they are not more than 100 ft. long is this: Find the sq. root of the radiating surface to be supplied; divide by ten and the answer will be the diameter of supply pipe in inches. This rule gives in this case 6.8 in. which will give a lower velocity of steam in the pipe but I think that a 6-in. pipe would be large enough.

As to the office which is 60 ft. by 60 ft. with an assumed height of 14 ft., the radiation would be about 1150 sq. ft., and that will condense 1150×270÷(3600×950)=.091 lb. or 1.25 cu. ft. of steam per sec. and 1.25×144÷50=3.61 sq. in. area or 2.14 in. diameter, so that a 2-in. pipe would be plenty large enough if the reducing valve was in the boiler room as I have allowed a low velocity.

If the reducing valve was placed at the heater and steam run to it at boiler pressure a 1-in. pipe would probably be sufficient. This would need to be trapped in the return line, but for the low pressure heating, I should by all means use a vacuum pump if possible, using Webster syphon return valves or their equivalent, as in that way the air is removed most effectively, thus making your heater more efficient and also reducing back pressure on the engine.

In figuring radiation surface, if the wall surface of the rooms is not all exposed surface, use rule cited above and leave out inside walls. A pound of dry and saturated steam at 15 lb. gage = 13.7 cu. ft. and a pound steam at 0 gage = 26.5 cu. ft.

S. E. Balcom.

Steam Questions

A CROSS-COMPOUND Corliss engine, 34x60x60 in., has a cylinder ratio of 1 to 3.1. It is claimed that using this ratio, 1 to 3.1, noncondensing, the engine has a low steam consumption. How do you explain that claim?

2. Is there any formula by which we can compute the velocity of steam at a given pressure in a vacuum? Example: What is the velocity of steam at 2 lb. gage in a 28½ in. vacuum?

3. A centrifugal pump at 1500 r.p.m. delivers 3000 gal. per min. Diameter discharge pipe is 10 in., suction pipe 12 in. diameter. The casing containing the revolving vanes is 30 in. diameter. How is the number of gallons found?

I have tried over and again to account for these 3 questions, but unfortunately I have not been able to solve them. J. C.

A. As to the ratio of compound engine cylinders, this depends entirely on the load to be carried, steam pressure and condenser pressure. One of the difficulties with the compound engine run noncondensing is that with a variable load and the cutoff varying, the efficiency of the engine changes considerably with changes in the load.

As you probably know, the object of using a compound engine is to cut down the condensation of steam during admission, and this is done by cutting down the number of expansions in each cylinder. Some designers claim that the number of expansions in both cylinders should be the same. Others claim, and it is more general practice, that the work should be equally divided between the 2 cylinders. As a matter of fact, the only designer who has been able to prove up his contentions in a large number of cases is Prof. Geo. I. Rockwood, of the Worcester Polytechnic Institute, who some years ago advocated a ratio of 1/7. This, however, would apply only on condensing engines with a large ratio of expansion. The list of cylinder ratios as given by different authorities for noncondensing engines runs as follows:

For 100 lb. gage boiler pressure	ratio 1 to 1.267
For 110 lb. gage boiler pressure	2.73
For 120 lb. gage boiler pressure	2.81
For 130 lb. gage boiler pressure	2.91
For 140 lb. gage boiler pressure	3.00
For 150 lb. gage boiler pressure	3.11
For 160 lb. gage boiler pressure	3.21
For 170 lb. gage boiler pressure	3.31
For 175 lb. gage boiler pressure	3.37

These are worked out on the basis of equal work in the 2 cylinders and cutoff at normal point of ¼ stroke in the high-pressure cylinder.

2. In the matter of flow of steam, the equation for computing this is rather complex, and is as follows:

$$\frac{V^2}{2g} = 8.41\ (1 - D^{0.110})\ p.v.$$

In this equation V is the velocity in feet per second, g is the acceleration due to gravity in feet per second and is 32.17. D is the ratio of the final pressure to the initial pounds absolute, p the initial pressure per sq. ft. absolute, v is the initial volume cu. ft. per pound of steam. This equation can only be used by means of logarithms.

3. In regard to your centrifugal pump problem, there are 2 figures lacking which are necessary to do anything with the pump capacity. One is the diameter of the impeller or revolving wheel, the other the width of the blades or of the passages, if it is of the closed impeller type. We should also have to know the head against which the pump is to work. The rule for computing the capacity is as follows:

Multiply the width of the impeller opening or blades at the rim, measured in inches, by the square of the circumference of the impeller at the outside measured in feet, and by the revolutions per minute. Divide by the square root of the head in feet against which the pump is working, and by 110,880. The head should be the sum of the suction and discharge heads. The final quotient will be the gallons per minute which the pump will handle.

You could get a rough idea of the capacity of the pump from the fact that the discharge velocity is usually figured at from 8 to 10 ft. per min. through the discharge pipe. A. L. R.

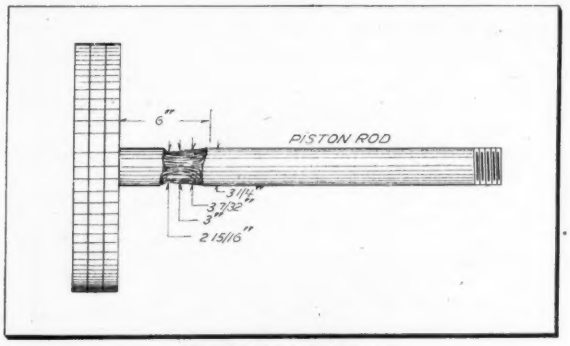
SUGGESTION HAS BEEN made that to designate the designer of machinery and the man who works with figures the word "Ingineer" be used, and for the man who handles the machinery and keeps things going the word "Engineer." The distinction is difficult to define and establish and the similarity of the words would certainly lead to confusion. If the designation is needed, it will be forthcoming from some bright mind.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

What Caused Damaged Rod

HERE is what is called an engine room mystery by all who saw the rod. We have 2 18 by 36 by 48 in. cross compound engines which, after being installed and run a short time, began blowing. The pressure carried is 140 lb. The erecting engineer was called in and he put on a soft piece of ring packing, but the engineer, not being satisfied, pulled the first piston out, the sketch



DEFECTIVE PISTON ROD

shows its appearance. Between 5 and 6 in. from the follower, the rod was rough and reduced in diameter 5/16 in. The other rod presented the same appearance and at 6 in. from the follower was 3/1000 in. small. The piston was central and everything in line. An explanation of the cause of this trouble is desired by the writer.

Walter Dewey.

Lubricant for Air Compressors

IN our plant we have converted an Artic ice machine into an air compressor. The air being used throughout the brewery, where it comes in direct contact with the beer forbids my using oil as a lubricant in the compressor. I have used glycerine but it forms a coat on the compressor head where there is no clearance and makes it dangerous. What can engineers suggest to overcome these conditions? Eugene Hibert.

Graphite for Boilers

WHAT experience have subscribers had with the use of graphite for removal or prevention of boiler scale, and what amount and how often should it be used for a hard water in a boiler of 150 hp.?

Refrigerating Plant Capacity

WE have an old plant that we run in the summer season 4 to 6 months each year. It is 12 yr. old and has the same brine in the tank and the same ammonia in the system that was put in when the machine was started. Of course we have added to them to keep up strength and quality.

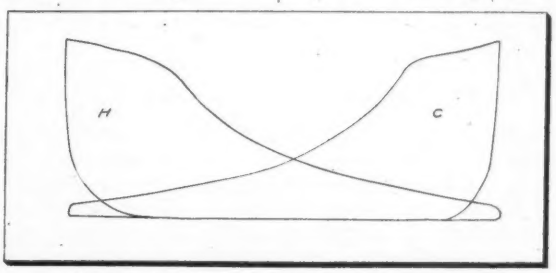
The plant was put in by the De La Vergne Co. and besides cooling an ice storage room about 200 ton capacity, was guaranteed to make 17½ ton of ice in 24 hr. The compressor is 10 by 20 double-acting and we run about 65 r.p.m., some times more and some times less but never over 75 r.p.m. We make 18¾ tons of ice in 24 hr. and do it 7 days in a week and 30 or 31 days in a month. The plant has had no improvements or repairs since it was put in, only such as would naturally be expected to keep it up and in running order.

In 1906 we put in a new storage room of 500 ton capacity and still the old plant turns out its ice just the same with the 2 rooms as it did before, only we have to watch things a little closer. We don't do it with the brine at 17 or 18 deg. F. nor do we stop the frost as soon as it comes out of freezing tank, and when we do stop it we don't always use the expansion valve for I have found that to make ice we have to expand ammonia. Now I would like to hear somebody's opinion in regard to the capacity which we should expect from this plant.

Frank H. Cordner.

Card From an Old Engine

I SHOULD like to have this diagram criticized. It was taken from a Watts-Campbell simple right-hand Corliss engine, built in 1881. The cylinder is



CARD FROM AN OLD ENGINE ¾ ACTUAL SIZE

24 by 48 in. stroke, steam pressure 80 lb., spring 50, r.p.m. 73. I should like to have some of the readers' opinions, also the i.h.p. John Graham.

Reducing Operating Costs

WE are in charge of probably an average manufacturing plant, considered from an economical point of view, the best type of simple noncondensing engines, but they wont do to hold our own against the big hydro-electric, and generating station using the unsalable coal that accumulates around the mines.

We must divide our present coal consumption by from 3 to 5 in order to make our own power at a profit in competition with the cheap power offered by these central stations. The management has already been offered current for about ¾ cent per kw. hr.,

although I imagine it would be a short-time contract and the price would be advanced as soon as the users were in a position in which they could not provide their own power.

To compete with this cheap power, what type of equipment shall we use? Producer gas power looks about as good as anything. We know of one gas power plant that divides our cost per hp. by 3; this plant generates electric current for motor service. would it not be better to hook our gas engines direct to the line shaft by means of belts or ropes and save the cost in the 2 conversions necessary in the electric drive?

Probably we could get our power cheaper with oil engines; if there is any truth in the claims made, we could do so. Another proposition that would help some would be to use the exhaust from one of the engines in a low-pressure turbine generating electric current for motors, shutting down all other steam-driven motors.

I suppose, to make this proposition complete, we should also install economizers, shouldn't we? Also, hadn't we better install the German uniflow engine in connection with the low-pressure turbine; this would increase the economy of our layout.

I have it figured out that the central station people will submit an offer just enough lower than they think we can make the power for, to get the contract until such time as they think they have us in the hole. As far as I have observed, these corporations charge all the traffic will bear. I am not altogether despondent when I take into consideration the various losses of the central station from the coal pile to the transformer, and our losses from the transformer to the countershaft, but realize the great need of more economical equipment.

In idle moments, will some reader plan an outfit for us that will make power so cheap that the central station can't touch us, the capacity of the plant to be 1000 hp.? We also need apparatus to tell us just what our power costs are; help us get this please. To date, we have had to depend on a sharp pencil to prove our side of the case, and feel the need of a few facts if the scrap is to be hotter. J. O. B.

Indicator Card Comments

IN regard to cards sent by J. S., July 15, would advise shortening the valve rod of crank end exhaust valve, which would give earlier release and earlier compression. The steam lines are good. Head end steam valve appears to leak, as the cutoff is practically same as on crank end—still the expansion line holds up too much. Take out the head end steam valve and examine it, if it is worn too bad, the valve seat had better be bored and a new valve fitted.

The expansion lines ought to cross each other at the middle of the card; they probably would were it not for the leak. The exhaust valve on the head end opens earlier than that on the crank end, yet the exhaust line is not as good as that of crank end. This I believe is due to the steam leaking through the head end steam valve. Tom Jones.

CRITICISM of readers on the engine diagram submitted by J. S. is asked for and in reply I wish to say that about the only fault is that the head end is doing more work than the crank end, also he should have a little more compression on the crank end. I find that the m.e.p. of crank end, 29.5 lb., of head end 31 lb., and the horsepower, crank end 63.1, head end 68.1, or 5 hp. more on the head end than on the crank end. The total hp. is 131.2. The generator load is $200 \times 550 \div 746 = 147.5$ hp. at the switchboard, or 16.3 hp. more than the indicated horsepower when it should be about 20 per cent less. It would appear the amperes and voltage were not correctly read, possibly one or both of the meters did not read correctly.

The only recommendation I would suggest is to equalize the cutoff; and give the crank end a little more compression. J. C. Hawkins.

(The cards as published were 47/59 the size of the originals, and calculations were corrected for this reduction.—Editor.)

IN regard to J. S.'s card, page 734, July 15 issue. Would say that terminal pressure of head end diagram is a little high, which probably accounts for the slightly higher back pressure at that end. Admission seems a trifle late by the rounded corners. As a whole the diagrams are good. Frederick M. Perras.

IN reply to J. S. in the July 15 number I would say that the m.e.p. for head end is 31 lb., crank end 29.5 lb., horsepower for head end 68.1, for crank end 63.1, making 131.2 hp.

There must be some mistake in the data given or else his gages or meters were not accurate as 200 ampheres at 550 volts gives 147.5 hp. from the generator which is quite out of the question.

In regard to his engine the valves appear to leak very badly. I have drawn the theoretical curve on the head end diagram; to account for the quantity of

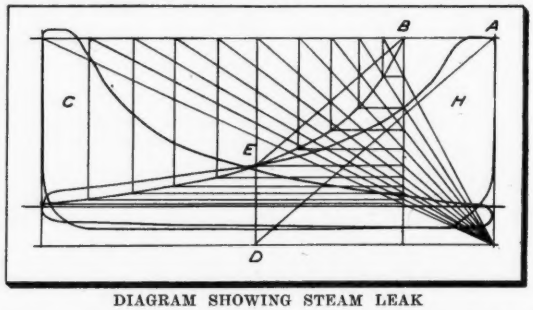


DIAGRAM SHOWING STEAM LEAK

steam in cylinder at point E the cutoff should be at B, the valves appear to leak the full length of stroke.

J. S. does not state if the steam pressure given is gage pressure or absolute, if it is gage he has an excessive drop in steam line as he only gets 68¾ lb. initial pressure in head end and 71⅞ lb. in crank end.

The release, compression and admission lines are very good, the head end is doing the larger part of the work, but the steam valves and the steam line need attending to. C. B. S.

(C. B. S. does not take clearance into account when drawing theoretical expansion which makes leakage appear greater than it really is.—Editor.)

Belt Troubles

IN regard to Mr. Robinson's troubles with the 20-in. belt, I wish to say that I consider it too wide to be laced with any degree of satisfaction. If I had the belt to look after, I would cut off the lace holes, scarf the ends down and cement in a piece of belting of the proper length, making the joint with the belt in place, using clamps and rods with long threads to hold the ends while the joint was setting.

As the belt has been in use some time, it must be well stretched, and with a well-glued joint there is no reason why the belt will not run a long time without resplicing, which would certainly be cheaper, as

Mr. Robinson states that it has to be laced quite often. He also states that it runs well at times, I think the shafting must be in alignment with the engine shaft, although I would check this up to make sure.

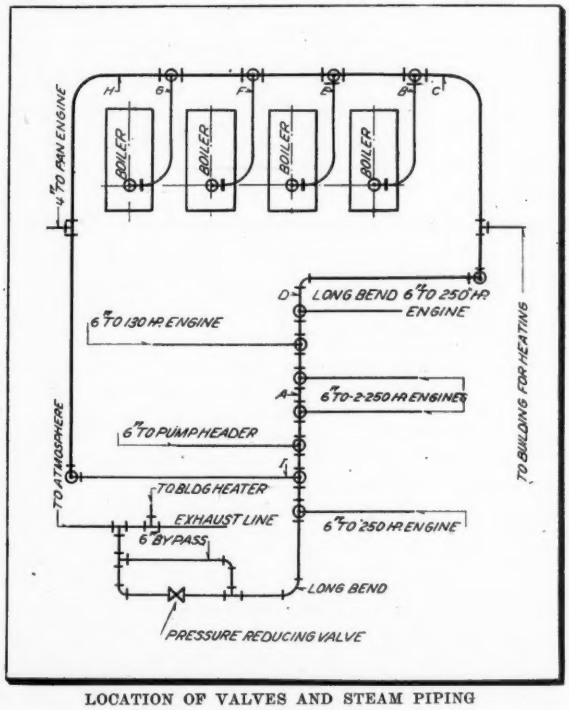
In drawing up on the clamp rods to make the splice, I would be careful to get as near as possible the same tension on each side of the belt, and, if one side pulled up more than the other, trim the ends so that the splice, when finished, will be straight and in line.

The trouble is, I think, that one side of the belt is laced tighter than the other side, bringing most of the strain on one side. This accounts for the frequent renewal of laces required. As to the bag in the compressor belt, he does not state whether it is laced or not, but if it is, I think this is the cause of the trouble, as it is almost impossible to get the joint of an even tension the full width, and the laces will not pull through the hole much.

There is another reason that might be responsible for the bag, and that is, that there was a poor piece of leather used in making the belt, which stretched more than the piece that was used in the other ply, and the constant working of the belt loosened the glue between the 2 pieces. J. C. Hawkins.

Valves and Steam Piping

IN regard to letter by J. C. Hawkins, page 795, August 1 issue of Practical Engineer, I would submit the following: Nine valves are required on the steam line; the valves and their positions on the line are indicated by the letters A, B, C, D, E, F, G, H and I, as per sketch. The valves B, E, F and G will enable



LOCATION OF VALVES AND STEAM PIPING

the engineer to cut in or cut out, either or all the boilers. This, together with all the other factors which enter into the problem, and as set out by Mr. Hawkins' letter, hardly need to be gone over in detail here. The positions of valves as indicated by the sketch seem to me the most advantageous and economical arrangement and number possible, conditions and requirements considered. Thos. C. Robinson.

CHARLES L. HUBBARD

Another Introduction to a Prominent Writer for Practical Engineer

CHARLES L. HUBBARD always had a liking for machinery, especially that connected with steam. There being no steam plants in his home town, Surrey, N. H., his natural yearning for something mechanical prompted an occasional visit to the neighboring city of Keene, where most of his time was spent in the various steam plants.

By the time he was 16, the construction of 4 small steam engines had been accomplished, the last containing 120 separate pieces; all 4 worked satisfactorily. His tools consisted of a hand bracket saw, 2 files, a small hand drill, a small vise, a pair of pliers, a spirit lamp and blow pipe (home made) and a jacknife. The raw material was sheet brass, and some old type, from which castings were made in wooden moulds.

At 21 Mr. Hubbard entered the mechanical department of the New Hampshire State College, preparing for the entrance examinations after working hours. His vacations were spent at work, one year in a machine shop and one at pattern making. With this start he took a post graduate course in Steam Engineering at Cornell University with special instruction under Professors Thurston and Carpenter.

After leaving Cornell, some months were spent in the drafting room of Brown & Sharp, Providence, R. I. About this time the Holly Steam Engineering Co., of the same city, needed a man of Mr. Hubbard's ability and offered him a position which he took, remaining with them 2 years.

He then went with Prof. S. H. Woodbridge of the Mass. Institute of Technology, and was with him about 7 years, most of the time as first assistant engineer in his private engineering office. While with Prof. Woodbridge, Mr. Hubbard was engaged in the design and superintendence of many large heating and ventilating plants under his direction, including such buildings as South Station, Christian Science Church, Dorchester High School, Stock Exchange, Boston; Cambridge Latin School; Eastern Maine Insane Hospital, Bangor, Me.; Royal Victoria Hospital, Montreal; Toronto University, etc.

The last few years of his work have been devoted largely to writing for various technical publications, preparing the text-books on Heating and Ventilation for the American School of Correspondence, and eight of "Machinery's Reference Series" pamphlets on "Power Plant Design" and "Shop Heating." Also he has written a book of some 600 pages, entitled "Power Heating and Ventilation," which is used quite extensively as a text-book in schools and colleges, including Mass. Inst. Technology; Carnegie Technical Schools, Pittsburgh, Pa.; Tulane University, New Orleans, La., etc. Two elementary books on heating and ventilation have also been written by Mr. Hubbard.

Mr. Hubbard is, therefore, well fitted to write interesting articles for practical men.

TO MAKE a flange joint proper, which will not leak or burn out on a steam pipe, mix 1 part red lead and 2 parts white lead to a stiff putty. Spread it on the flange evenly and cut out a liner of gauze wire, and lay it on the putty; then bring the flanges fair, put in the bolts and turn the nuts on evenly. For a durable and permanent joint is first-class.

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STEADY OPERATION

That a high load factor is important to economical operation of a plant is well understood, since boilers, engines, generators and other machinery must carry a good part of their rated capacity to get best efficiency, and variable load necessitates keeping in operation units larger than best operating conditions call for.

Even with load steady, however, it is possible to save or waste energy by careful maintaining of balanced conditions or otherwise. Some recent tests, details of which will be published shortly in Practical Engineer, go to show that such a seemingly trivial matter as shutting down the feed pump for a time when a plant is well adjusted for steady running, and then starting up and running fast to bring up the water level in the boiler will affect the steam generation of the boiler so that an hour or more is necessary to regain the steady balance of energy demanded and energy generated.

To get the best results, everything must be handled on a regular routine; steady load, steady steam flow, constant water level, regular water feed, regular firing; and disturbance anywhere along the line results in "surging" of conditions that produces loss. Routine and systematic repetition may be dull, but they are effective in getting the best results. The best use of brains is in studying the routine and system to see that they are the best possible, then seeing that they are maintained, not in doing a thing a different way each time "to see what happens." A reason for doing things and stick to it until a good reason offers for changing simplifies life and work. Eyes and mind alert to catch the good reason for changing avoids getting in a rut. There is a large difference between steady, systematic operation and stolid operation.

OFF DUTY

Boiler Artillery

Funny what things do actually happen, which would be impossible if they weren't so. It's easy to see why a boiler shell should give way when the pressure gets too high for it; or a tube sheet crack or pull off the tubes when it isn't well braced; or why a tube should expand and work loose in the head. But The Locomotive, from which we abstract the following stories, gives an instance at the Eufaula Cotton Mill, Ala., where a tubular boiler shot its tubes endwise out of both heads, and bombarded the vicinity with enthusiasm not to say enmity. It was particularly spiteful toward an oil tank which was punctured 4 times, and a fifth tube went through a nearby smoke stack.

Now, why should tubes act so and how could they get any force to shoot them endwise out of the boiler through a window, across a gully and railroad track and then have energy enough to pierce the tank shell? The pressure in the boiler is sidewise, not endwise on

the tubes, and even if it got an end push there is only a small ring of surface to act on. One feels to declare with the backwoodsman who had inspected a giraffe carefully for the first time, "Gosh darn, thar ain't no sich animal."

But it actually happened and there are witnesses to prove it.

Fixin' 'Er Up

Necessity being reputed as the Mother of Inventions must have a peculiar sensation when she looks over some of her children. But Shiftlessness and Ignorance must be the polyandric fathers of some repair jobs that are perpetrated. A boiler inspector's life may not be a gay one, but it certainly has variety, and novelties are frequent; one which is a near champion for inefficiency was found by E. J. Enoch of the Hartford Steam Boiler Inspection & Insurance Co. What would you say to a patch on a boiler carrying 125 lb. pressure, cemented to the outside and held down by a few bricks? Nice, safe proposition, isn't it? And so effective in stopping a leaking crack!

Well, that's what he found. The crack was 5 in. long on the rear drum of a Hawley down draft furnace, starting at a tube hole. So the original genius fitted a ⅜-in. plate over the drum to straddle the tube, plastered it well with asbestos cement, slapped on the patch and rebuilt the brick deflecting wall on top. It held, that is, it didn't blow off; but the leakage! That went into the furnace and helped (?) the combustion. This method of patching is not highly recommended, even by the inventor.

Tight Lacing

From a southern inspector of the same company comes a tale of unique reinforcement against explosion. It was the traditional sawmill boiler which had a steam leak on a longitudinal seam, and the fireman, mindful of lap joint cracks, feared she might "bust."

Here came the proprietor to the rescue with log chains. He wrapped these around the boiler in a spiral, until he "judged" there were sufficient turns, hauled everything taut with a yoke of oxen, made fast and then drove wedges under the chains at several points to make them still tighter. Then, of course, the boiler was safe? But the story doesn't say that the inspector advised insuring the boiler, even with this safeguard.

SUBMERGED COAL STORAGE

WITH the possibility of a coal shortage or difficulty in shipment always at hand, the maintaining of a sufficient supply of coal to meet emergencies becomes a problem to be reckoned with, in plants where operation may not be stopped without serious damage. To provide against such a condition, the Omaha Electric Light & Power Co. has built a submerged coal storage pit capable of holding 6000 tons, to be kept under water so as to avoid the loss of fuel value by exposure to air, and to prevent danger of igniting by spontaneous combustion.

Last winter the company was called on not only to keep up its own service, but to supply coal for household consumption and for some outside refrigerating plants. With this in mind, the pit has been so arranged that an overload capacity of 10,000 tons is possible.

The floor of the pit is carried on piles which are driven through the earth and quicksand to solid rock and are capped by concrete blocks 2½ ft. square and 12 in. deep. The piles are driven on 5 ft. centers under the whole floor area, the thought being to take all the weight of the coal on the piles and none on the earth. The rock is from 25 to 35 ft. below the surface of the ground and the floor of the storage pit is 14 ft. below ground level.

To protect the concrete floor from injury by the grab bucket in removing the coal, rails are imbedded at frequent intervals. The pit is located west of the power house and between it and the power house are 2 receiving hoppers over which runs the switch track from the railroad. Spanning the hoppers and the pit is a grab bucket coal crane, one end traveling on a girder on the power house and the opposite end on the top of a concrete wall 46 ft. 8 in. high from the bottom of the storage pit and 26 ft. above ground level, which serves as a support for the end of the crane and as a fire protecting wall for adjacent buildings. On the other 3 sides of the pit, the walls rise 22 ft. above the floor or some 8 ft. above ground level.

The cost of the installation was about $30,000, of which about $8000 was due to the foundations used.

RUBBER COVERED

By V. C. Wood

DYNAMO used for lighting a large mill and running 1200 r.p.m. was belted to an overhead center-shaft just inside the engine room door. I had looked my engine over, and finding everything alright, had just settled down in the old arm chair for a quiet smoke, when the dynamo let out a screech that could have been heard a block away, the commutator was just a ring of fire for a second, when off came the belt, and promptly wound around the counter-shaft. To say that I was startled would be putting it mildly.

As the belt was between me and the door, I had to wait until the "super" came with a lantern. I shut down the engine which also ran a paper machine. We put the belt back on and started up, but before the dynamo got up to speed it ran off again, I then threw all the switches, some 28 in number, and after getting up to speed began throwing them in, when I reached the line that ran to the sulphite department I discovered it was short. After looking this mill all over I finally discovered it. A fellow had wanted a light in another corner of the basement, he found a couple of brass wires and connecting them to the line, twisted them together and run them through a rubber tube to his lamp socket, the fuses on this line had been blown and replaced with copper wire, so when he threw in the switch to light the basement the above was the result. I asked him why he did such a thing as that and he said he supposed that if the wires were covered with rubber that they would work all right. It would be better for the readers to imagine the rest I said to him than for me to express it here. Suffice it to say he was given a "short circuit" lecture on rubber covered wire which lacked nothing in verbal pyrotechnics since I had so recently had an illustration of the electrical variety.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

A NEW DEPARTURE IN CENTRIFUGAL PUMPS

The Rees RoTURBo Impeller Creates Pressure Head Directly Instead of Speed Energy to be Changed to Pressure by the Diffuser

UNTIL about 10 yr. ago it was generally agreed that centrifugal pumps were suitable only for low lifts and large volumes of water, such as occur in irrigation, sewage, salvage work and for circulating water for condensers.

The efforts of early designers that the centrifugal type should not be limited to a few of the pumping problems of the world is shown by the patents taken out in the attempt to overcome the recognized difficulties, and to make the centrifugal pump suitable for high lifts by using a number of impellers in series.

No doubt the delayed development was largely due to the fact that to get the best results from a centrifugal pump, the impeller should be of small diameter running at high speed, rather than of large diameter running at low speed. But, until the advent of the electric motor and steam turbine there was no means

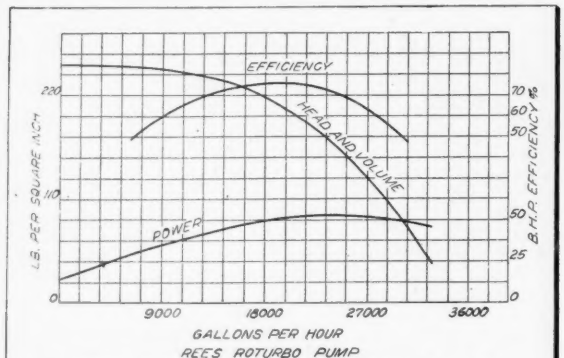


FIG. 1. CHARACTERISTIC CURVES FROM TEST OF ROTURBO BOILER FEED PUMP DESIGNED FOR 220 LB. HEAD AND 18,000 GAL. AN HOUR

of driving centrifugal pumps at the necessary speed except through belting or gearing with their inseparable difficulties and losses in transmission, which neutralized the advantages gained at the pump.

With the introduction of electric motors and steam turbines, high efficiencies became possible and for high lifts the old arrangement of impellers in series was revised and the centrifugal pump has become a strong competitor of the plunger pump for conditions which used to be looked upon as suitable only for reciprocating pumps.

Perhaps the defect which has been the most difficult to overcome and which has decided the buyer, in many cases, against this type of pump, has been the fact that it would work at its best only at the exact head for which it was designed.

The problem of varying heads has been completely solved by the invention known as the Rees Pressure-chamber Impeller, which was placed on the market in Europe in 1907 by the Rees RoTURBo Manufacturing Co., of Wolverhampton, England. The invention has been protected by patents in every country in the world by the parent company, the Rees RoTURBo Development Syndicate, Ltd., Wolverhampton, England, and pumps are being sold under license in most of the European countries.

The pump illustrated herewith constitutes an entirely new departure, the name "RoTURBo" having been registered to denote the type.

The sole rights to manufacture and sell RoTURBo pumps in this country and Canada has recently been obtained by the Manistee Iron Works Co., of Manistee, Michigan, a firm which has been manufacturing pumping machinery and condensers since 1871.

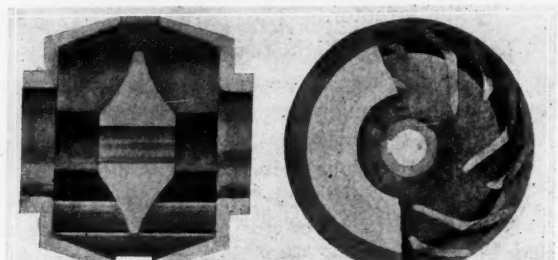


FIG. 2. SECTIONS OF ROTURBO IMPELLER

The characteristic feature of this pump is, that it is a true turbine pump, the turbine effect being secured by making the rotor of large capacity for storing water which is maintained by rotation at a constant maximum internal pressure with the minimum amount of loss, consequently, instead of throwing away the surplus speed energy of the water discharged when the head of delivery is reduced, the energy is extracted from the water before it leaves the pump casing. Pumps of this RoTURBo design present such marked characteristic differences in their operation and action as compared with known types, as in effect to constitute them a new class.

In a pump constructed as described above, it is found that the power absorbed when running at a constant speed remains practically constant for all heads of discharge and heights of suction possible, and never appreciably exceeds that required for the total head for which the pump is designed. Thus, such a pump is self-regulating, as it is impossible by any variation

of head or suction to throw excessive load or strain on the driving motor. There are no moving on parts in contact, except at the bearings. The internal arrangements are such that the whole pump is in hydraulic balance and without end or lateral pressure on the shaft.

In the characteristic curve of the RoTURBo pump, Fig. 1, it will be noticed that the power rises to a maximum at about normal head and volume, but the head can be reduced to any extent without affecting the power curve. The discharge can be reduced below the atmospheric line, into vacuum, without any effect except reducing the power required for the motor.

In the RoTURBo pump the design differs from the ordinary impeller or flat disk runner, which is formed with the main object of securing velocity of the water in the expanding channels of the fixed casing.

With the RoTURBo pressure-chamber, the water, after being picked up at the eye, from both sides, becomes practically stationary relative to the pressure-chamber itself, thus eliminating friction losses, and generating a pressure by centrifugal force.

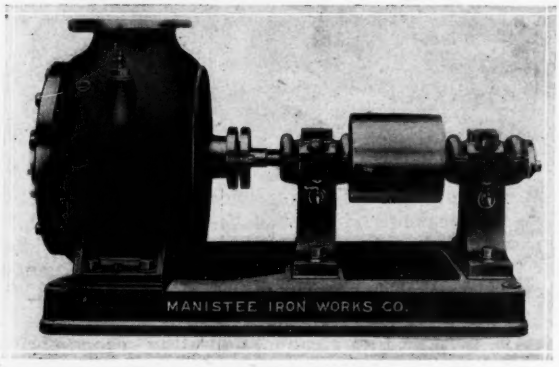


FIG. 3. ROTURBO PUMP FOR LOW HEAD, BELT DRIVEN

The inner portion of the impeller between the eye and the largest section of the pressure-chamber may be looked upon as a centrifugal pump proper and the blades of this portion are designed similar to those of an ordinary centrifugal pump. The rim portion, beyond the pressure-chamber, is designed with reaction turbine blades having rearwardly directed nozzles, discharging from the pressure chamber.

The pump is, therefore, always discharging with a constant pressure, which is the ideal condition for a centrifugal pump, and the turbine is always discharg- from a constant pressure which is the ideal condition for a turbine. The result of a combination of a pump and turbine, with a pressure-chamber between them, is that the self regulation is perfect, and at any heads lower than normal duty the power taken from the motor is prevented from rising. As the speed of the water in passing through the pressure-chamber is reduced, internal friction is reduced to a minimum and a high efficiency is secured without the necessity of machining or polishing blades or surfaces. The internal wear is also minimized.

In practice it is found with this type of pump that the highest efficiency point is at a duty in which the speed of the water issuing from the turbine blades is about half the peripheral speed of the impeller. Consequently, the resulting speed in relation to the fixed casing is greatly reduced. As a result of this the diffusers may be removed some considerable distance from the periphery of the impeller, and as there is nothing in the path of the water after leaving the impeller, and the speed of the water is low, it has been shown from all results that there is no tendency to wear at this point, even when pumping gritty water.

The illustrations show examples of these pumps for

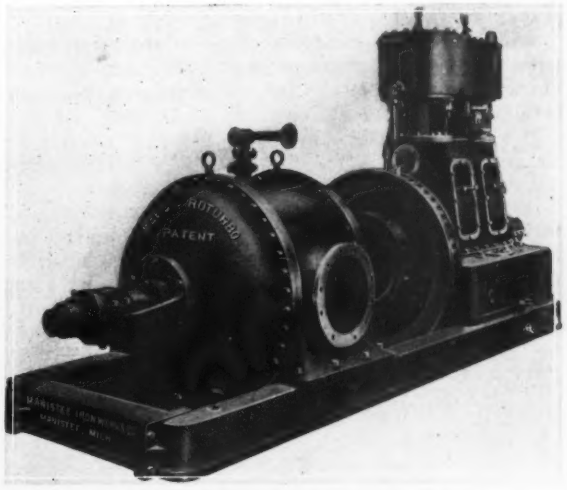


FIG. 4. STEAM DRIVEN PUMP OF LARGE CAPACITY

wide range of duties with their respective curves showing the actual power absorbed and the efficiency, and it is worthy of note that the efficiencies procured from RoTURBo pumps are permanent efficiencies as the results depend little upon diffuser effect in the casing, and is not affected when wear takes place.

In the type of RoTURBo, Fig. 2, all the diffusers in the fixed casings are eliminated so that any suspended matter which passes through the pressure-chamber of the impeller has a clear flow through the fixed casing. The style which is a stock type meets all usual requirements for low heads, although embodying the simplest parts and construction, requiring no special care in machining, so forming a cheap type of pump.

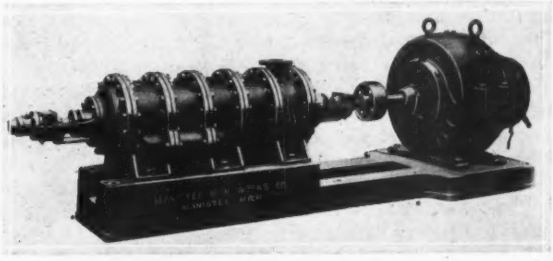


FIG. 5. BOILER FEED PUMP WHICH GAVE THE RESULTS SHOWN IN FIG. 1

Figure 4 shows a steam driven RoTURBo pump, of 400,000 gal. capacity an hour that was installed in Nova Scotia. This was driven by a direct connected steam engine of 300 hp. running at 400 r.p.m. The pump delivered water against a head of 150 ft. The test at the works gave an efficiency of 84 per cent at the duty point.

Figure 5 represents the latest type of the Rees RoTURBo boiler feed pump, direct coupled to an enclosed ventilated, direct-current motor. The pump

impeller consists of a series of pressure-chambers which are mounted upon a central shaft supported upon bearings throughout the whole length except that portion passing through the chambers. The feed pump, on test, delivered 18,000 gal. per hour against a boiler pressure of 220 lb. per sq. in., and took 50 hp. to drive it, showing a pump efficiency of 76.5 per cent, as seen in Fig. 1.

An interesting example of a comparatively low speed RoTURBo pump running at 925 r.p.m. gave the high efficiency of 84 per cent. The duty of this pump is 150 ft. lift and a delivery of 158,400 gal. per hour at the above speed, Fig. 6, the diameter of the discharge pipe being 12 in. The overall efficiency of the pump and motor was shown to be 75 per cent.

When this pump was tested at the works the following results were procured: Starting from the duty point, viz. 158,400 gal. an hour at 150 ft. head, the power is reduced from 120 hp. to less than 40 hp. as the discharge valve is closed. To the right of the curve when the discharge valve is opened so as to reduce the head against which the pump is working, the

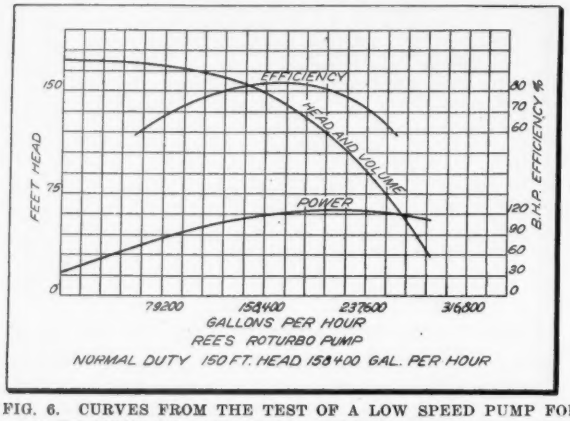


FIG. 6. CURVES FROM THE TEST OF A LOW SPEED PUMP FOR 150 FT. HEAD AND 158,400 GAL. AN HOUR AT 925 R. P. M.

volume with minimum pressure is increased to double that at normal duty, showing that there is no throttling in the pump and no reduction of capacity.

Therefore, the RoTURBo type of pump giving self-regulation and high and permanent efficiency at constant speed coupled with the modern high speed prime movers such as electric motors, steam turbines, gasoline engines, etc., finally removes the limitations of the centrifugal pump entirely and the above facts show that there are few conditions of pumping for which RoTURBo type of pump is not fitted.

RoTURBo pumps are operating for pumping sewage, mines, coal mines, boiler feed, pressure augmenters for city service, fire protection, dock pumping, cooling towers and condensing plants.

They are also being used, with exceptional advantage, for fire-engine service. A machine equipped with a 50-hp. engine adapted to drive either the machine or the pump, as required, attained a speed of 40 miles an hour when running on good roads. The efficiency obtained at the pump, viz. brake horsepower to water horsepower, was 74 per cent when working at the duty and against a pressure of 120 lb. per sq. in.

Due to the self-regulating characteristics of this pump, the streams can be delivered through any number of hose lines without over-loading the engine when the head is reduced. Consequently, the maximum power of the engine can be utilized at all times.

BOILER TUBE CLEANER

Adapted to Steam or Air Drive

AIR or steam driven types of boiler tube cleaners have been found the most satisfactory in many power plants, because water is expensive or the pressure is too low to give sufficient power to drive a water turbine cleaner.

Plants in which these conditions obtain, will undoubtedly be interested in a new type of air or steam driven cleaner, recently perfected by the Lagonda Mfg. Co., of Springfield, Ohio. The cross sectional cuts of this cleaner shown herewith, give a good idea of its method of operation. The compressed air or steam passes through 2 ports in a plate in the rear end of the cleaner, then through transverse openings in the rotor, and out through branch openings to the space behind the paddles. There are only 2 ports opening into the air chamber, thus only the 2 paddles that are doing the work are under air pressure, and there is no communication to the 2 idle paddles, thus

FIG. 1. LAGONDA AIR OR STEAM-DRIVEN CLEANER

one of the main difficulties with air driven cleaners, excessive leakage of air, has been eliminated. After the air has done its work behind one of the paddles, the paddle uncovers an exhaust port and the expanded air is allowed to pass out through the front end of the cleaner.

To permit the cleaner operating economically, under different air pressures and in different hardnesses or thickness of scale, 2 interchangeable rear plates are provided having different sized port areas. Where there is a limited amount of air available, the plate with the smaller holes can be used, thus insuring

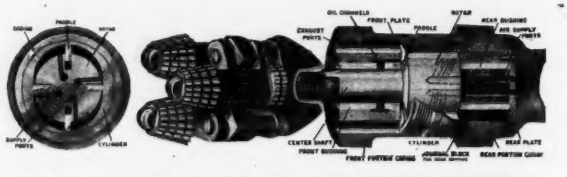


FIG. 2. DETAILS OF LAGONDA AIR OR STEAM-DRIVEN CLEANER EQUIPPED WITH A QUICK REPAIR HEAD

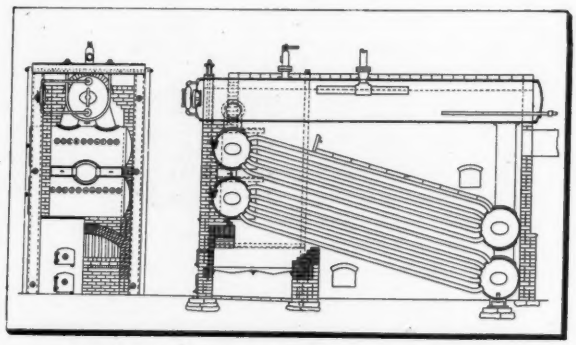
plenty of power with small amount of air. If the scale is heavy and plenty of air can be furnished, the plate with larger holes can then be used and more power developed.

Due to the efficient design and sturdy construction, the makers claim that this air cleaner will develop more power with less air consumption than any other type so far perfected, and to prove their claims, they are willing to lend their cleaner to any reliable firm and allow them to test it out thoroughly for themselves.

The cleaner is furnished with either the Weinland Quick Repair Head, or with other types manufactured by this company, and is built for cleaning tubes to 4 in. in diameter and a special design is suitable for use in curved tubes.

A CYLINDRICAL HEADER WATER TUBE BOILER

CARR cylindrical header water tube boiler is a new type and is built in sizes ranging from 80 to 1000 hp. by the Carr Boiler Company, of Chicago, Ill. All units between 80 and 150 hp. are designed to enter space now entirely monopolized by boilers of the horizontal return tubular or marine type due to low head room, and as heretofore users have had no choice other than those mentioned, there should be a successful future in store. This boiler is designed with 5 rows of 3½-in. tubes expanded into cylindrical headers front and rear large enough for a man to enter and handle a turbine cleaner for removing the scale that forms in the tubes. These headers are connected to a steam and water drum of suitable proportions by connections of large area, thereby insuring an unrestricted circulation.



SECTIONAL VIEW OF CARR CYLINDRICAL HEADER WATER TUBE BOILER

Boilers of larger size are designed with 2 or more sections of 5 tubes each in height, therefore, boilers of any desired capacities can be estimated. No stayed surfaces are used in any part of the boiler, all parts cylindrical, insuring strength and freedom from obstructions for scale or other impurities in the water to deposit on.

Unlike other water tube boilers of the horizontal inclined type, the Carr boiler is not provided with hand hole plates opposite each end of each tube, and which have to be removed and replaced when the boiler is cleaned. This makes it possible to clean the boiler quickly and cheaply and get it back on the line with small expense and little interruption of service.

Many other desirable features are incorporated in the makeup, which should appeal to users, engineers and others having anything to do with boilers.

AN INTERESTING ACCOUNT of the production and use of graphite is given in a report by Edson S. Bastin, of the United States Geological Survey. He tells of the methods of mining in different localities, of the manufacture of artificial graphite and of the various uses, among others, that for lubricating, and says that: "The addition of graphite to oil results in a lower frictional resistance than would be obtained by the use of oil alone. The quantity of oil required for a given service is also reduced and a lighter grade of oil may be employed without decreasing the quality of the lubrication. A small quantity of graphite only is required, and the benefits derived from its use persist long after the application has ceased."

NEW DIFFERENTIAL GAGE

For Recording Differences in Pressures or Water Level in Boilers

FIGURE 1 illustrates a new differential recording gage which has just been placed on the market by The Industrial Instrument Co., of Foxboro, Mass., showing the values for admission of pressures, the difference between which is to be recorded.

The moving element consists of a patented pressure tube movement as used in Foxboro designs of improved pressure recorders. For ranges below 10 lb. per sq. in. the diaphragm tube as per Fig. 2 is em-

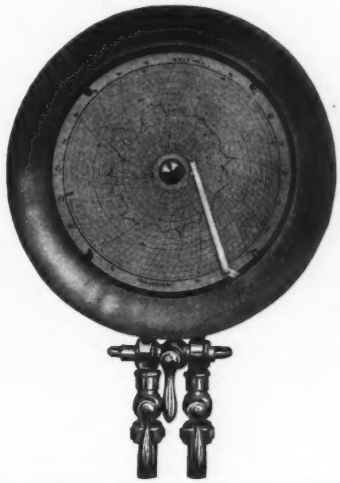


FIG. 1. INDUSTRIAL INSTRUMENT CO.'S DIFFERENTIAL RECORDING GAGE

ployed, and for differential pressure exceeding 10 lb. per sq. in. the Helical tube movement as per Fig. 3 is used. In both, it will be noticed that the pen arm is directly attached to a shaft giving a substantial support and rigidity to the movement. A friction joint is supplied in the pen arm, in line with the shaft, making adjustment possible, where necessary and without affecting the length of the pen arm.

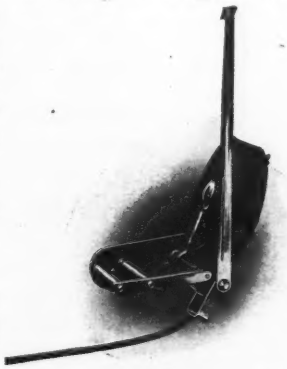


FIG. 2. DIAPHRAGM TUBE FOR PRESSURES BELOW 10 LB.

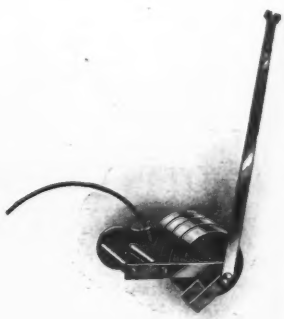


FIG. 3. HELICAL TUBE FOR PRESSURES OVER 10 LB.

A pressure tube of the required range to cover the differential pressure desired is employed. One of the 2 pressures, the difference between which is to be recorded is applied internally to the pressure tube and the other is applied externally; the principle being the same as in ordinary practice with the difference that one pressure instead of being atmospheric is replaced by some other pressure.

Transmission from the movement to the pen arm is obtained through a special bearing through the wall of the chamber enclosing the movement. It will be readily seen that there is practically no limit to the range of the difference or static pressure under which this recorder can be successfully used. It is especially adapted to measure the flow of fluids by means of Venturi or Pitot tubes.

One interesting and very useful application is for recording the height of water in a boiler. Figure 4 is a fascimile of chart and record for 24 hr. of the height of water in the gage glass of a 125-hp. return tubular boiler in a small electric light plant operating 24 hr. a day. Applied to the water column, the recorder gives a record not only of the height of water,

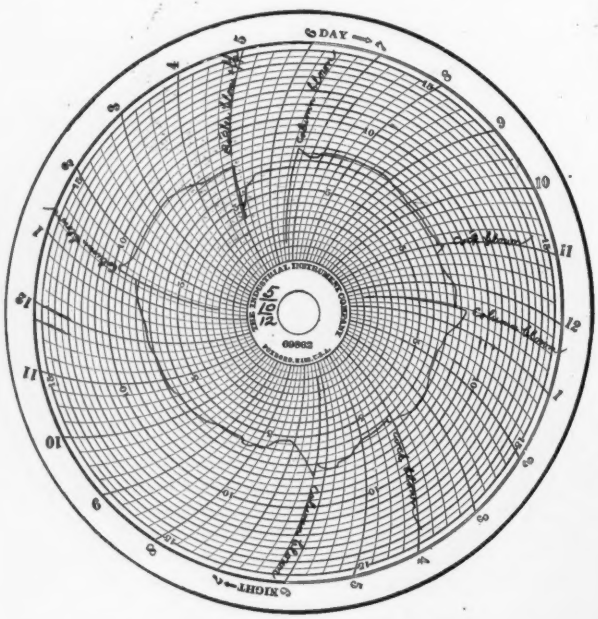


FIG. 4. RECORD FROM WATER LEVEL GAGE

but an accurate record of the time the water column or gage glass is blown, the time and amount the boiler is blown off, and any other disturbance affecting the height of water in the gage glass.

Further information can be obtained from the manufacturers.

ELLIOTT FILTERS AND GREASE EXTRACTORS

ELLIOTT filters and grease extractors are made in 2 types, single and twin. The single filter consists of a filtering chamber containing the filtering media, and a base which is divided to direct the flow through the filtering chamber, or by-pass when cleaning. Valves are provided at either end of the base to cut the filter in or out of service.

Filtering media is Terry cloth, double thickness, supported by spacers and spreaders around a central column. The single filter is suitable for general service and applicable to the majority of conditions, where the filtration of a liquid is beneficial. Owing to the fact that the liquid must be by-passed for several minutes while the filter is being cleaned, the best results would not be obtainable from this type if the quantity of impurities was excessive, or constant and continuous filtration was demanded.

The twin filter, as its name implies, consists of 2 filtering chambers having a common base. Otherwise its construction is similar to the single filter, except the elimination of the by-pass which is unnecessary. It is suited to all conditions of filtration service, more especially those conditions where a constant and continuous supply of filtered liquid is necessary; it is particularly well suited to central station service or service where the normal capacity of the plant is exceeded for periods of operation. Having 2 filtering chambers, one of the filters is in constant service.

Construction

INLET and outlet connections are in a direct line and it is unnecessary to make any special arrangements for piping to accommodate this filter.

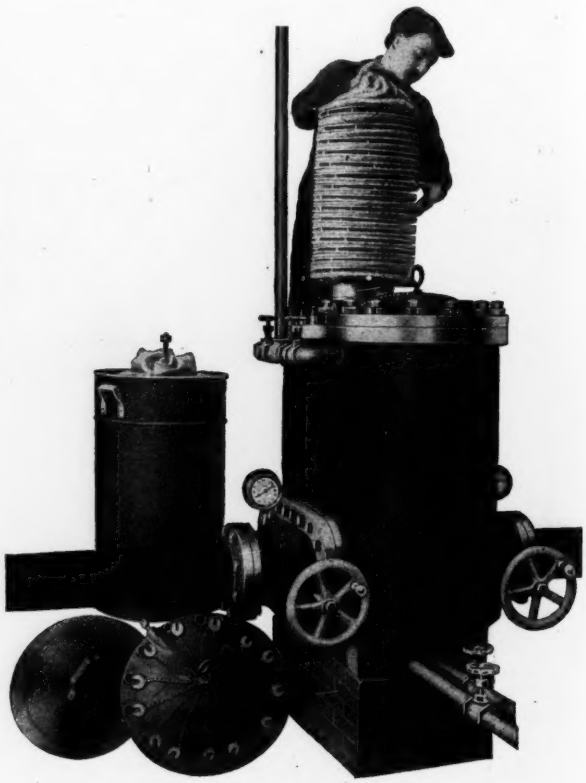


FIG. 1. TWIN FILTER AND GREASE EXTRACTOR

Filtering chamber is placed in a vertical position, permitting the interior to be freely withdrawn and is a decided advantage in making exchanges. The base, chamber and connections are of cast iron. The valves are bronze mounted, and the valve seats are bronze.

Valves and seats are made special for this particular service and are of the sliding gate type, one valve serving 2 ports. Special wedges automatically take up any wear and force the valves tightly on their seats when directly over the ports.

The cover is a detachable type, with inserted gasket; it is unnecessary to remove the nuts from the studs to take off the cover. By slightly slacking off on the nuts, the slotted washers can be easily withdrawn and the holes in the cover are of sufficient

diameter to clear the nuts on studs. The washers are attached to chains to insure against loss and be always ready for replacement.

Operation

REFERRING to the cross section, the liquid to be filtered enters at the left from the pumps, passes up and out through the central slotted column, coming in contact with the filtering media, consisting of 2 thicknesses of linen Terry mounted on spreaders and spacers. This media removes the impurities, the filtered liquid passing into the surrounding chamber, down and out at right into the line to a closed heater, boilers or where desired.

Owing to the entire elimination of perforated metals in contact with the filtering media, the water passes through the filtering material with very little friction. The continued use of the filter will result

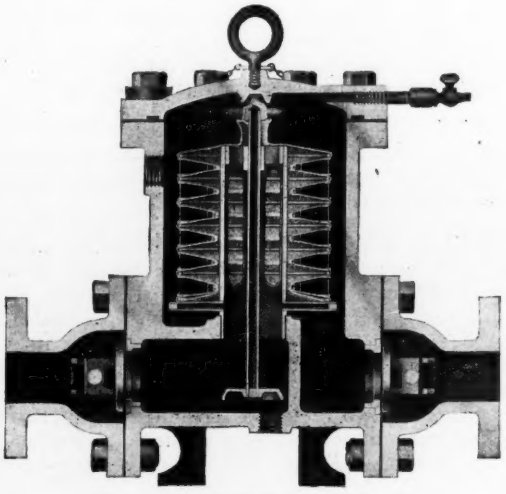


FIG. 2. CROSS-SECTION OF FILTER

in foreign substances accumulating on the surface of the filtering material and increased resistance. This resistance is at all times shown by the pressure gages, connected on both sides of the filtering material, and a pre-determined difference will indicate the necessity of cleaning.

These filters are made by Elliott Co., Pittsburgh, Pa.

NEWS NOTES

F. W. GOLDTHWAIT, Boston selling agent for the Betson Plastic Fire Brick Company, has removed his office from the Tremont Bldg. to 19 Pearl Street. Minnesota Supplies Company, which also represents the Betson Plastic Fire Brick Company, has removed its offices from the Providence Bldg. to 316 Columbia Bldg., Duluth, Minn.

MERIDEN ASSOCIATION of Engineers No. 1, of Meriden, Conn., would like to receive catalogs and literature from all manufacturers of steam power appliances, to be filed in its rooms for the use of the members.

LEROY A. KLING has just accepted a position with the Wheeling Mold & Foundry Co. of Wheeling, W. Va., as sales manager of the Road Machinery Department. This concern has built much important machinery for the Panama Canal, and will manufacture a modern crusher, adjustable to crush to any size, pulverizers, rolls, screens, elevators, trucks and graders.

EXAMINATION will be held to fill a vacancy in the Engineer of Tests, at Watertown Arsenal, Mass., on September 21. Applicant must have graduated in civil or mechanical engineering, and have not less than 3 years' experience in metallurgical work and tests of materials. The examination will be in the form of record submitted, of training experience and original investigations with corroborative evidence and the vouchers of 2 persons, preferably engineers, as to the fitness of the applicant for the position. Age, 25 years or over; open to all citizens of the United States. Applicants should write to the Civil Service Commission, Washington, D. C., for Form 1312 and instructions. Applications must be filed before September 21. The salary paid will be $2000 a year.

E. P. GOULD has been appointed sales manager of the Steam Appliance Co., of Milwaukee, Wis., and will henceforth make his headquarters in that city. This company manufactures Triumph Oil Separators and Exhaust Heads, Victor Oil, Steam and Ammonia Separators, Peters Steam Traps and other specialties. Mr. Gould is well known in the Chicago and Milwaukee territories, as having been in charge of sales for The Lunkenheimer Co. for many years.

COLUMBUS MACHINE TOOL CO. of Columbus, Ohio, has placed contracts for a new and modern plant in that city for the manufacture of gas, gasoline and oil engines up to 600 hp., mechanical stokers, shaking grates, pipe machines, piston machines and the like. Until the new plant is completed, the manufacturing will be done in the plant of the Columbus Machine Co. C. H. Palmer is president of the Columbus Machine & Tool Company, which is a new firm organized in June with capital stock of $500,000 to take over the business of the Columbus Machine Co. of Columbus and the Vulcan Furnace Co. of Warren, Ohio.

CATALOG NOTES

HUNT AUTOMATIC RAILWAYS are described in a catalog recently issued by the C. W. Hunt Company. It explains and illustrates how coal, ore, sand, rock, clay, salt, etc., may be economically handled by Hunt automatic cars, the special feature of which is the self-dumping arrangement adapting them for discharging material to bunkers or storage yards from elevated tracks.

WATER LIFTED BY COMPRESSED AIR is the subject of a 70-page, 6x9 catalog, Form 75, just issued by the Ingersoll-Rand Co., 11 Broadway, New York City. During recent years much progress has been made in the art of pumping water by compressed air. The Air Lift has proven especially useful for city and town water-works, asylums, hospitals, plantations, railways water tanks, irrigation, private country homes, pumping mines, ice manufactories, breweries, cold storage and packing houses, textile mills, dye works, bleacheries, sewerage installations, dry-docks, seaside water-works, stock farms, etc., in fact, anywhere and everywhere that clear and abundant water is needed. In this catalog the Ingersoll-Rand Co. explain very thoroughly the different methods employed and gives figures showing actual cost of operating various installations. The air lift involves the

use of an air compressor, located where the expense of attendance is least; an air receiver adjacent to this compressor; a pipe line for conveying the air from the receiver to the wells; one or more wells drilled to a depth proportionate to the height of the lift and the depth of the water strata below the surface; air and water pipes running down inside of these wells, the proper proportion of their vertical length being submerged when at work, representing the pumping apparatus proper. Catalog is profusely illustrated to show the workings of the different systems.

TO SHOW the mechanical strength of Burt ventilators the Burt Mfg. Co. of Akron, O., illustrates in a catalog recently issued a Burt ventilator supporting

a weight of 1762 lb. Strength is not the only strong feature of Burt ventilators as explained in this catalog devoted to Oil Filters, Exhaust Heads and Ventilators.

BULLETIN NO. 1 from the Lexington Instrument Works of Lexington, Ohio, describes the Smith Recording Gas Calorimeter Type A, which, by means of a traveling-chart and calorimeter, automatically records the quality of gas being furnished at all times. The bulletin tells how the calorimeter operates and also gives results which have been obtained by its use in producer gas plants.

VIEWS OF ITS WORKS and some of its products are presented by the Mesta Machine Co. of Pittsburgh, Pa,. in an interesting and attractive booklet of some 50 pages showing heavy gas engines, steam engines, blowing engines, hydraulic forging presses, gears and rope drive pulleys.

AN INTERESTING BOOK showing something new in steam pipe coverings is found in the catalog of the Armstrong Cork Co. of Pittsburgh, Pa., entitled Nonpareil High Pressure Covering. It tells not only the peculiar composition of the material used for these coverings, but gives interesting tests and data made in laboratory and plant to show the nonconducting power of the coverings and the saving in condensation by application. It is a beautifully printed book and one which is a delight to the eye as well as informing to the mind.

STANDARD ELECTRIC drills and portable electric grinders, as made by the Standard Electric Tool Co. of Cincinnati, Ohio, are illustrated and described in bulletins B-6 and G-5 recently received.

REDUCING COAL CONSUMPTION and Increasing the Efficiency of the Power Plant are the subjects of a booklet issued by the Yarnall-Waring Co. of Philadelphia and devoted to a description of the operation and accomplishment of the Lea V-Notch Water Flow Recorder. It tells how this recorder works, what it can accomplish for the engineer in the power plant and the different styles available and for what purposes they are particularly adapted.

BULLETIN NO. 15 of the Milne Water Tube Boiler Co. illustrates some recent installations as well as the details of construction of the Milne boiler and the economizer which goes with it.

THOSE WHO HAVE to deal with lighting problems will be interested in the bulletins of the engineering department of the National Electric Lamp Assn., 2 of which have recently come to hand. Bulletin 2-A tells of the department and what its work is, the assistance which it has given and is ready to give to engineers on lighting problems. Bulletin 3-B describes the Gem Metallized Filament lamp, showing the first cost, the operation and the total cost of producing light at different costs of power per kilowatt hour.

WOOD PRESERVING MACHINERY as made by the Power and Mining Machinery Co. is described in Bulletin G-35 which treats of the causes of timber destruction, the steps necessary to guard against these different causes and the equipment which must be provided in order to give proper treatment.

TO THOSE INTERESTED in the question of corrosion of pipes, Bulletin No. 10 of the National Tube Co., Pittsburgh, devoted to the relative corrosion of iron and steel pipe as found in service will be of great interest. The discussion is by Wm. H. Walker of the Massachusetts Institute of Technology and shows photographs from actual cases in hot water lines, boiler feed lines, oil pipe lines, and gives the results of comparative investigations over a wide range of service and location. The conclusion is that taken on the average there is no difference in the corrosion of iron and steel pipes.

FRANK L. PARKER & SON CO. of New York City is bringing out a hot water tank which will use live steam, exhaust steam or steam from a domestic heating system and takes care of the expansion of the steam tubes without straining the shelves and at the same time returns the condensation by gravity to the boiler in the case of a low pressure system. The heater is fully described in a folder just received which gives complete details.

Sparks From The Advertising Pages

Have you ever stopped to think of what your situation would be if there were no such thing as advertising? Has it ever occurred to you how much you owe to modern methods of publicity?

Just to illustrate this point we are printing below a letter from Mr. A. E. Morgan, of Lower Hutt, New Zealand, who has selected the advertisements in Practical Engineer which have impressed him most from the three viewpoints which we suggested some months ago.

The Floshes,
Fitzherbert St.,
Lower Hutt,
New Zealand.

Practical Engineer,
537 S. Dearborn St.,
Chicago, Ill.,
Gentlemen:—

I consider the advertisement of the General Electric Company to have the best attention value for very few people can resist the temptation to stop and inspect any thing which lays claim to be the largest in the world of its class. But it also has another claim to one's interest and that is the high degree of reliability that must be embodied in such a machine to induce the New York Edison Company to replace seven machines by one.

I have been much interested in the advertisements of the Cling-Surface Co., because the photograph which invariably heads their advertisement is so convincing of the efficacy of their method of belt treatment. The reading matter always repays one for looking through for it is always interesting.

The advertisement of "A. Allan & Sons," is the most convincing because the directness of the wording of the advertisement inspires confidence in them and the general bearing of the advertisement indicates character.

I have written to the Cling-Surface Co. and to A. Allan & Sons for literature.

Yours sincerely,
A. E. Morgan.

Mr. Morgan was attracted by the advertisement of the General Electric Company because it contained the illustration and description of something which represented progress in his profession—the largest machine in the world of its class—a machine that had replaced seven others in the plant of the New York Edison Company. It was interesting to note that such a machine was now being made—a really fascinating bit of news information.

The advertisement of the Cling-Surface Company interested him because it showed a new method for treating belts—more news from the field of progress.

A. Allan & Sons showed him where he could be sure of getting a reliable product which he evidently needed.

Away over there in New Zealand Mr. Morgan is in just about as close touch with the latest development in power plant operation as the engineer in the biggest cities of America.

Twice a month he reads of the latest and best equipment which is being manufactured for the power plant; and he has ready access to it all.

But what would his situation be if there were no such thing as advertising? How would he have heard of the products which he is investigating?

We have emphasized the value of advertising as a guarantee of worth—as an insurance of reliability. This is certainly an excellent example of its value as a means of keeping abreast of the times.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—By an engineer, 20 years experience in central stations. Strictly sober. Married. Age 38. Address Box 234, Practical Engineer, Chicago, Ill. 9-1-2

POSITION WANTED—By A1 reliable engineer. Understands slide valve, Corliss and equipment, condensers, plant lighting, etc. Address Box 197, Jennings, La. 9-1-2

POSITION WANTED—By gasoline engineer to run a pumping plant; understands wells and pumps. Wants all-year-round work. Married. Good references. Address Marshall Hughson, 11 E. Travis St., Grand Rapids, Mich. 9-1-2

POSITION WANTED—As oiler in power plant. Can do steam fitting, and handy all around man. Have had four years experience. Please give full details in reply. Address Box 238, Practical Engineer, Chicago, Ill. 9-1-2

POSITION WANTED—Engineer 31, married, with 10 years' experience with steam engines, dynamos, ice machines, turbines, etc. Wants steady position, Rhode Island or the state of Connecticut preferred. Address Box 245 care of Practical Engineer, Chicago, Ill. 9-15-2

POSITION WANTED—Experienced steam-electrical engineer will consider position of engineer in charge or superintendent of light plant in a small town. Iowa or Nebraska preferred. Iowa license. References furnished. Address Box 246 care of Practical Engineer, Chicago, Ill. 9-15-2

POSITION WANTED—By an engineer; 9 years experience in central stations and heating plants. Parsons Turbines. Strictly sober. Married. Age 27. Minn. state Chief Eng. license. Best of references. Address Box 240, Practical Engineer, Chicago. Ill. 9-1-2

Help Wanted

SALESMAN WANTED—Traveling in the Middle West, to handle the best known and most successful rocking grate on the market. Salary or commission. Address Box 242, Practical Engineer, Chicago, Ill. 9-1-2

HELP WANTED—ENGINEER WANTED in every city and town to instruct our customers in indicator practice. If you have a fair working knowledge, we will "do the rest." Good pay to reliable, intelligent men. Write for particulars. Lippincott Co., Newark, N. J. tf

Wanted

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. tf

WANTED—SALESMEN TO WORK counties calling on voters for our New Census publications. Largest publishing house in the world back of you. Permanent if satisfactory. Establish your future now. Men making $50 to $75 per week. Rand McNally & Co., Dept. B, Chicago, Ill. 8-1-5

For Sale

FOR SALE—New 30 H. P. Ball Automatic Horizontal engine. Lucas & Son, Bridgeport, Conn. 9-15-6

FOR SALE—WAINWRIGHT HEATER, 400 H. P. copper corrugated tubes, excellent condition, low price, Harris Machinery Co., Minneapolis, Minn. 7-1-6

FOR SALE—Two American Saw-Mill Machinery Co. 6 inch water turbines, one with and one without cast iron casing. Address F. E. I., 5540 Woodlawn Ave., Chicago, Ill. 9-15-1

FOR SALE—INDICATOR REDUCING WHEEL, planimeter, best make, in fine order. Examination allowed before payment; price low—in fact, a sacrifice. Address Mrs. N. L. Browing, East Orange, N. J. tf

FOR SALE—Two 16x20 Russell, 4 valve Corliss automatic engines, latest and most improved style, 18 months service, practically new, $500 each. Duzets Sons, Hudson Terminal, New York.

FOR SALE—HIGH PRESSURE BOILERS, 54x16, 60x16, 66x16, 72x18. Corliss Engines 10x30, 12x36, 14x36, 16x42, 18x36, 18x42. Generators, Motors, Miscellaneous Machinery. The Randle Machinery Co., 1767 Powers St., Cincinnati, Ohio. 7-15-6

Patents and Patent Attorneys

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf

PATENTS BRING WEALTH; proof—books—advise—Free. Low rates, easy terms. A. Wedderburn, Pat. Atty., Washington, D. C. 9-15-3

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson and Son, Patent Solicitors, 710 G St., Washington, D. C. 9-1-2

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf

Educational and Instruction

A SWINGLE'S TWENTIETH CENT'Y Hand Book Free to the subscriber who writes the best 750 word article on the reading matter he likes best in Practical Engineer, and why? Address the Contest Editor. 9-1-2

Miscellaneous

IRON, BRASS and Aluminum Castings, Metal Specialties, Patterns, Models, Polishing, Plating and Japanning, North Chicago Tool Works, 65 Grove Ave., North Chicago, Ill. 6-1-12

MAKE MONEY on the side. Here's your chance to pick out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash-Younker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf